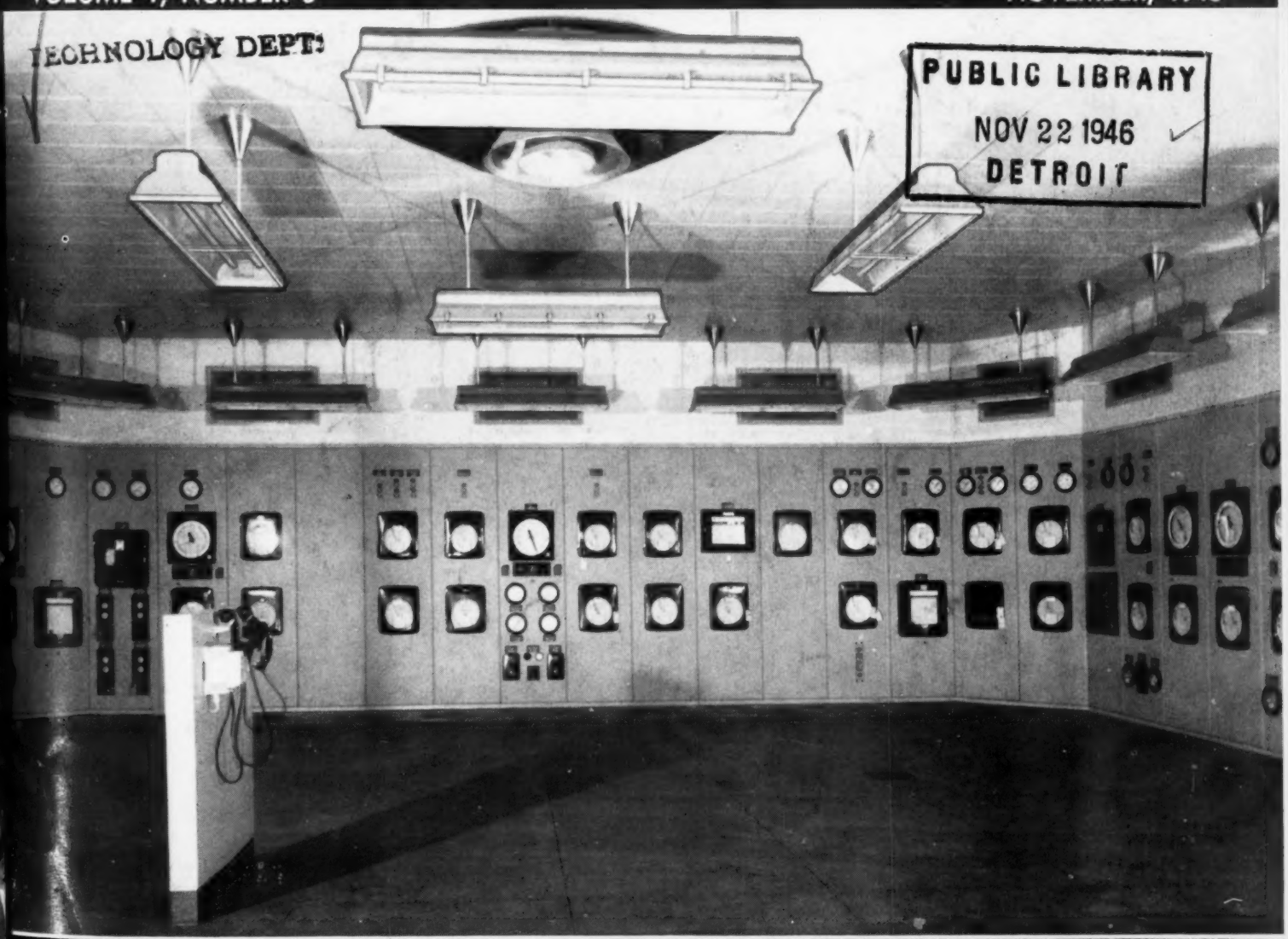
PETROLEUM PROCESSING

VOLUME 1, NUMBER 3 NOVEMBER, 1946



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PUBLICATION OFFICE

Cleveland 13, Ohio.....1213 West 3rd St.
CHerry 7672

NEWS BUREAUS

New York 20, N. Y.....50 West 50th St.
Washington 4, D. C.....1034 National Press Bldg.
Chicago 5, Ill.....59 East Van Buren St.
Tulsa 3, Oklahoma.....904 World Bldg.

PETROLEUM PROCESSING

Of Crude Petroleum and Natural Gas
For Fuels, Lubricants and Petrochemicals
REFINERY OPERATION, MAINTENANCE, EQUIPMENT, DESIGN

FORMERLY MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS

COMING MEETINGS

November

7-8, Society of Automotive Engineers, National Fuels and Lubricants meeting, Mayo Hotel, Tulsa.

11-14, American Petroleum Institute, Annual meeting, Stevens Hotel, Chicago.

17-20, American Institute of Chemical Engineers, Annual meeting, Bellevue-Stratford Hotel, Philadelphia.

18-22, American Society for Metals, Annual Metal Congress and Exposition, Municipal Auditorium, Atlantic City, N. J.

21-22, American Standards Association, Annual meeting, Waldorf-Astoria, New York City.

December

2-6, American Society of Mechanical Engineers, Annual meeting, Hotel Pennsylvania, New York City.

2-7, 17th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City.

12th, Chemical Market Research Association and Technical Service Association, First open meeting, Hotel Roosevelt, New York City.

30-31, Division of Industrial and Engineering Chemistry, 13th Chemical Engineering Symposium on Distillation, Mellon Institute, Pittsburgh.

THIS MONTH'S COVER. . .

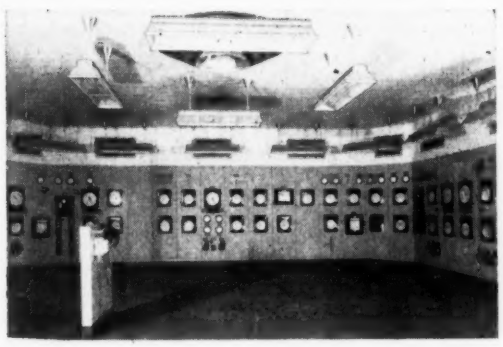

Photo courtesy Standard Oil Co. (Indiana)

Latest devices for recording and automatic control of processing units, as well as improved design of a central control room, are illustrated in this interior view of the control room of the new 25,000 b/d Fluid catalytic cracking unit at the Whiting refinery of Standard Oil Co. (Indiana). The unit went on stream Oct. 14. The room features a soundproofed ceiling, air-conditioning facilities, and fluorescent lighting. Details of the huge cat-cracker may be found in this issue of PETROLEUM PROCESSING on page 163. For information on the many new developments in the field of instrumentation as reported at the recent National Instrument Conference in Pittsburgh, see page 219.

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★ Exclusive in PETROLEUM PROCESSING

Published monthly by The National Petroleum Publishing Co., 1213 West 3rd St., Cleveland 13, Ohio. Publication date—first Tuesday of each month. Subscription rate, $3.00 a year in United States and its possessions, $3.50 a year elsewhere. Single issues, 35 cents per copy; back copies more than three months old, 50 cents per copy. Formerly published (prior to September, 1946) as the Technical Section of National Petroleum News, devoted to REFINERY MANAGEMENT and PETROLEUM CHEMICAL TECHNOLOGY and including International Petroleum Technology. Trade mark registered U. S. Patent Office.

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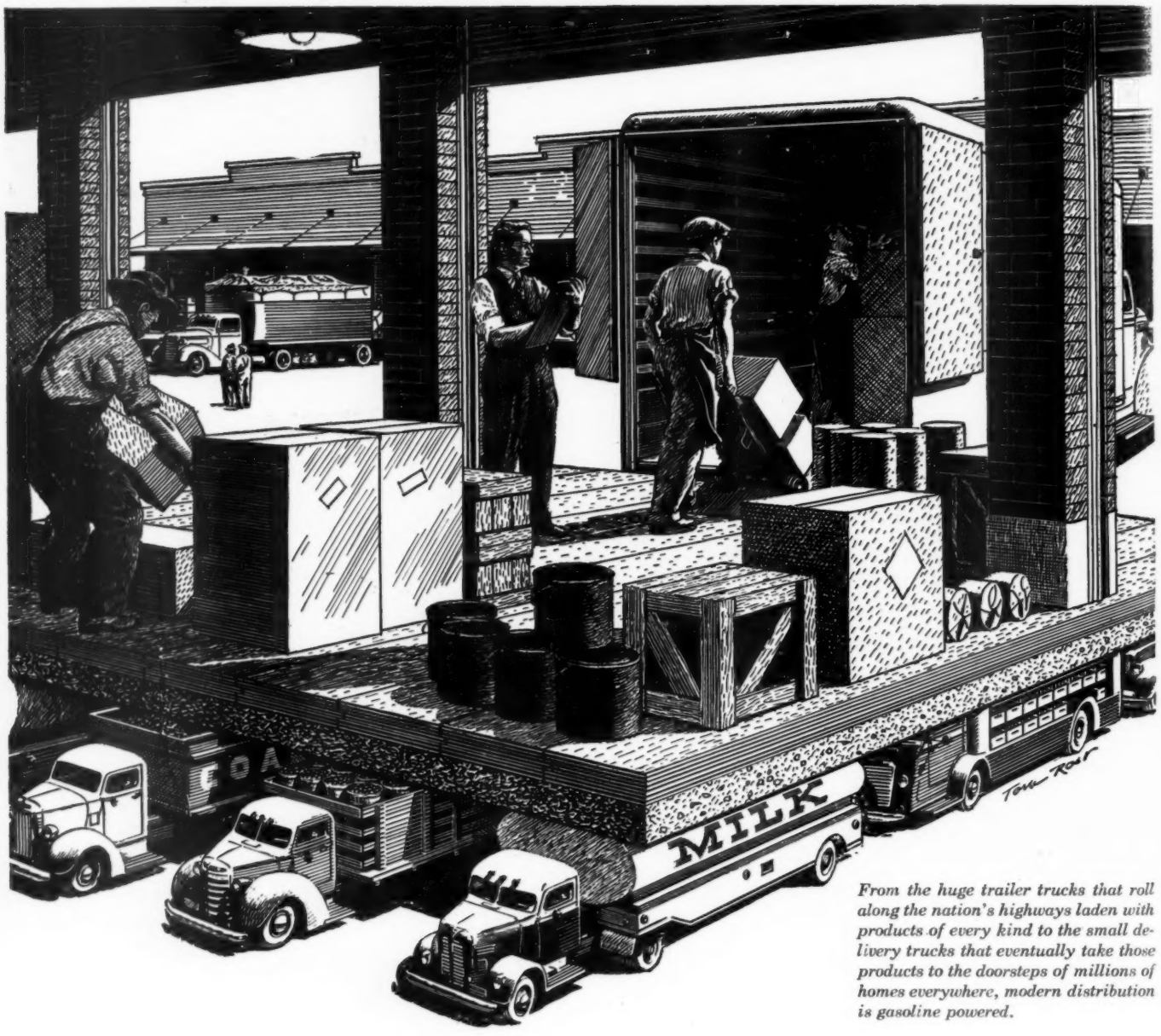

From the huge trailer trucks that roll along the nation's highways laden with products of every kind to the small delivery trucks that eventually take those products to the doorsteps of millions of homes everywhere, modern distribution is gasoline powered.

Distribution cost depends on gasoline

ONE WAY to make money is to manufacture a product and sell it in volume at a profit. But between the making and the selling comes the problem of *distributing* it economically to the nation's markets. To do this, America's business men are depending more each year on gasoline power. And the more they depend on trucks to deliver goods to wholesalers, retailers and homes, the more value they get from each reduction in the cost of gasoline transportation.

During the past twenty years this cost has been reduced substantially. Gasoline itself costs less per gallon than it did in 1926 *in spite* of increased taxes. And by producing increasingly *better* gasoline—through improved refining methods and the use of antiknock fluid made by Ethyl—refiners have made possible the development of more powerful engines that provide better, more economical transportation.

Nor have the limits of fuel and engine progress been reached by any means. As oil refiners will continue to improve gasoline, automotive engineers will design engines capable of converting its extra available power into greater payloads, faster schedules, lower delivery costs. It is toward this end that Ethyl research engineers, today as in years past, are working in close cooperation both with oil companies and with automotive companies. Ethyl Corporation, Chrysler Building, New York 17, New York.

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Reduced Structural Height Design Feature Of 25,000 Bbl. Fluid "Cat-Cracker"

Supporting Reactor and Regenerator at Same Platform Level in Whiting Refinery Installation Saves About 20% in Overall Height; Also Improves Operating Efficiency of the Unit

By WILLIAM C. UHL
Staff Writer
PETROLEUM PROCESSING

THE new 25,000 b/d Fluid catalytic cracking unit which went on stream Oct. 14 at the Whiting refinery of Standard Oil Co. (Indiana) represents a saving of approximately 20% in overall height when compared to war time Fluid units of the same capacity.

Improvements in conventional design were utilized in the big "cat-cracker" so that, while it is one of the largest capacity units of its type in the country, it stands only 210 ft. above grade, or about 16 stories. Some of the war time installations of Fluid units of 15,000 b/d capacity are about 253 ft. high. In the Whiting installation the reactor and the regenerator were located side by side and supported on the same platform levels, a feature which results in the lowest overall height possible from any previous arrangement and which assists materially in reducing operating and maintenance costs, it was pointed out.

This design in arrangement makes possible low and substantially equivalent operating pressures for both vessels, about 10 psig, as well as optimum operating pressures for the flow of catalyst and oil. Low pressures were selected because operations have indicated that high pressure in the reactor is more conducive to carbon formation and results in lower quality gasoline. Low pressure in the regenerator also minimizes catalyst deactivation and reduces utility costs which means improved operating efficiency.

Generous Use of Alloys

Because the unit was designed for processing high sulfur stocks, generous provision has been made for stainless steel and chromium type alloy protection against corrosion at all critical points.

Alloy-lined carrier lines have been utilized where needed, and alloy cladding has been provided for the reactor. The fractionator tower is equipped with 18 pressed steel fractionating trays and 8 baffles, and is lined with a 7/64 in. thick stainless steel liner spot-welded to the entire interior of the vessel.

The presence of sulfur in the cracking unit charge stock creates, in addition to corrosion problems, quantities of hydrogen sulfide gas which must be carefully watched, especially in closed areas, such as compressor rooms, pump houses, and other utility buildings.

As a novel H_2S detecting device, Indiana Standard uses canaries, in cages suspended in each of the closed areas. Canaries have been used in coal mines for many years, but this is probably one of the few times they have ever gone to work for the oil business.

A conventional preheating furnace using either gas or oil as fuel has been provided to bring the feed to an initial temperature of about 750° F. Although it is practical to operate a so-called "heat balance" Fluid cat-cracker, in which the heat formed in catalyst regeneration is sufficient to keep the unit at operating temperature, such a unit, while lower in first cost, can operate at desired efficiency only on the originally planned feed.

If the amount or nature of the feed stock varies, or if product requirements differ from those originally anticipated,

a heat balance unit (without furnace) would be lacking in flexibility with respect to control of conversion level. A feed preheat furnace can provide this flexibility by furnishing additional heat input to the reactor—independently of the heat from the combustion of coke.

In the design of the Fluid unit at Whiting and its accessory equipment, all possible advantage was taken of the experiences gained from construction and operation of war time units, refinery engineers said.

In the control room, instrument and recorder panels, occupying three sides of the room, were located between six and eight feet from the outer walls, thus permitting easy access behind them for maintenance work.

Sound-proofing in the ceiling, fluorescent lighting, air-conditioning, and a floor of durable, non-dusting red cement are features of this up-to-date control center. Three telephones are provided, for city service, for plant service, and for communication within the unit itself.

On the unit itself, rapid and easy access to the various platform levels is assured the operator by a high speed passenger elevator. In addition a second, larger, and slower lift is provided for the use of the mechanical crafts in transporting materials and equipment. From the standpoint of safety, the unit is provided with adequate blowdown systems and flares capable of handling quick and safe elimination of hydrocarbons from any or all sections in case of emergencies.

11,600 b/d Gasoline

Processing gas oil from high sulfur content West Texas crude, the Whiting cracker will produce about 11,600 b/d of high quality motor gasoline, 2600 b/d of butane suitable as alkylation feed stock or for use in the production of other chemical compounds, and 9700 b/d of cycle gas oil in two streams, half of which will be suitable for domestic heating oil. The balance of the cycle gas oil will be charged to thermal cracking units and converted into more gasoline, according to Dr. R. T. Myrick, assistant to the manager of the Whiting refinery.

There will also be produced 7,500,000 cu. ft./day of excess gas for use in the refinery or for making chemical compounds, Dr. Myrick said.

In operation the Whiting Fluid unit uses about 500 tons of catalyst which is circulated at the rate of 2,600,000 lbs./hr. Something over 200 tons/day of coke is deposited on the catalyst. Excess heat resulting from burning this coke off the catalyst in the regenerator is used to generate steam for use in the unit.

Reactor temperature is held to about 910° F., while maintaining a 6.8 to 1 catalyst to oil ratio. Two stages, each containing four cyclones in parallel are employed in the reactor; three stages in the regenerator with six in parallel.

The fractionating tower is designed to operate at about 9 psig, and to produce overhead gas and unstabilized gasoline products which are sent to the vapor recovery unit, and side streams of light and heavy gas oils. Bottoms pass to a slurry settler from which decanted oil and slurry recycle are withdrawn.

Spent catalyst is carried by a portion of the regeneration air into the bottom of the regenerator, which is designed to operate at about 1025° F. and 10 psig. Recycle catalyst cooling is employed to control the regenerator temperature.

The coke burning capacity of the regenerator is in excess of 16,000 lbs./hr., with regeneration air being supplied by a 5400 hp compressor discharging 3,030,000 cu. ft./hr. of air from its fourth stage at 27 psig.

The 22 ft. 6 in. by 50 ft. reactor and the 37 ft. 10 in. by 40 ft. regenerator were welded in the field from shop fabricated sections. All welds were completely X-rayed for the detection of any flaws. Each vessel was completely stress relieved on completion and prior to being placed in service.

In conjunction with the new cracking unit, but not as an integral part thereof, is a vapor recovery plant capable of processing the total gas and distillate output of the cracker. This unit is designed for operation at pressures sufficiently high to allow the recovery of the propane-propylene fraction. However, the recovery of the C_3 cuts is not contemplated at present.

The vapor recovery unit is of conventional design. In operation, liquid and vapor products from the cracking unit are charged to the absorber tower fitted with a reboiler and a stripping section. The absorber operates at 75 psig and uses stabilized heavy naphtha as the lean oil. Rich oil is denuded in a lean oil still which operates at 90 psig.

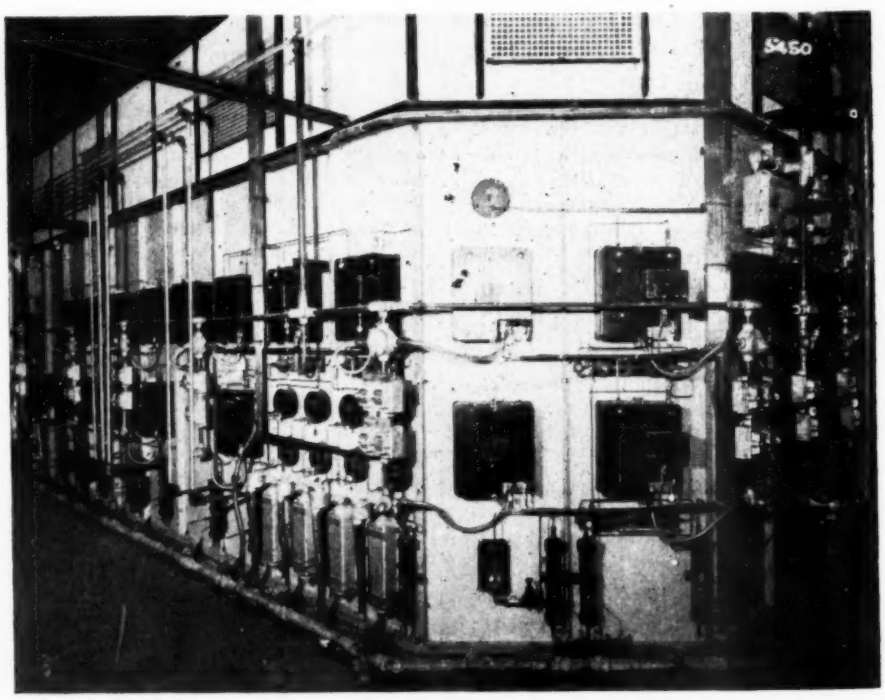
Part of the lean oil bottoms stream is recycled to the absorber, and the net production of stabilized heavy naphtha is withdrawn to storage. Overhead from the still is completely condensed and charged to the stabilizer tower which operates at 295 psig. Dry gas is eliminated overhead from the stabilizer, and stabilized light catalytic naphtha is withdrawn from the base. The vapor recovery unit is operated to obtain about 95% butane recovery.

Construction of the new Whiting unit started in May, 1945, and was completed in Sept. 1946, after which the new unit underwent extensive tests before going on stream.

Standard Oil Co. (Ind.) technical personnel supervised the design and construction which was handled by M. W. Kellogg Co. on the cracking unit, Foster-Wheeler Corp. on the vapor recovery unit, Stone & Webster Co. on utilities and Lummus Co. on yard piping.

First of Four Units

The unit is the first of four planned as part of a $150,000,000 expansion program covering various branches of Indiana Standard and subsidiaries. A unit of similar design and capacity is now under construction alongside the new one at Whiting; completion of another is expected next year at Sugar Creek, Mo.; and a fourth of smaller capacity will be built in Casper, Wyo.



Picture taken behind panel in control room of new cat-cracker. Note large space provided for maintenance work

TOMORROW

...IN PETROLEUM TECHNOLOGY

Current technological and economic developments discussed here in the light of their future bearing on petroleum refining operations include:

- **Shale oil patents are being surveyed.**
- **Research on wax is yielding valuable results.**
- **Fluidization is now being applied to the coking of coal.**
- **The Canadian government plans to profit by U.S. synthetic fuels research**
- **New company begins acrylic resin production.**
- **Possible comeback rumored for steam cars.**

Shale Oil Patents Are Being Surveyed

THE Bureau of Mines, as part of its synthetic liquid fuels program, is engaging in research on the production of shale oil and its refining into petroleum products. In connection with this, the Bureau has prepared a compilation and analysis of "all patents concerned with the treatment of shale oil and its products."[1] It is interesting to note that more than 2,000 pertinent patents (including foreign) have been identified—about 800 from the U. S.

These patents, as may be expected, cover all phases of the subject from oil shale retorting to hydrogenation, cracking, and desulfurization. A recently patented development is concerned with the adaptation of the fluid catalyst technique to oil shale retorting.

According to the article quoted;[1] "It is proposed to publish abridgments of each patent in the form of an illustrated index to the art and to include some interesting facts." Presumably, this patent search, when published, will be available for use by the petroleum industry.

It may be safely presumed that most of the basic patents relating to shale oil technology have long since expired, but it also seems likely that some of the most recent patents cover phases which have the greatest economic potentialities.

Patent searches are of considerable value for several reasons: (1) they serve as a guide to valuable information which may not be reported elsewhere, and (2) they help to avoid later patent entanglements by revealing phases of a subject that have already been patented. In short, they enable a research group to avoid duplicating research (except where confirming experiments are deemed necessary), thereby saving research money and —more important—the cost of future patent litigation in a lost cause, in addition to large sums which might have to be paid to the owner of an infringed patent.

In the case of shale oil, commercial operations are probably not so imminent that patent entanglements are greatly to be feared, but the search in question should certainly add to the dissemination of information in a field in which at least several petroleum companies are engaged.

Valuable Results From Research on Wax

PARAFFIN wax is a high-tonnage petroleum product which for some reason has not always been given all the attention it deserves. This situation is now apparently being remedied, and it appears that paraffin wax will assume increasing importance in its old uses and will find new ones, including use in chemical and lubricant synthesis.

In a recent bulletin of the Technical Association of the Pulp and Paper Industry,[2] it is noted that the blending with wax of another petroleum derivative, polybutene, "modifies its (the wax's) crystallinity to the extent that it becomes more flexible."

Polybutene, apparently marketed to the paper industry in admixture with wax under the trade name of Tervan 349, 449, etc., is a rubbery hydrocarbon (isobutylene) polymer marketed elsewhere by Standard of New Jersey under the trade name "Vistanex." It has an amorphous structure, and its "lack of a definite melting point makes mixing (with wax) difficult in paper-converting plants." Standard therefore blends it with wax at the refinery and then sells the commercial grades to converters, who can further dilute these mixtures with additional paraffin wax in the equipment which they now use for the latter alone.

The Tervan-wax mixture "is now used as a laminating medium for waxed paper and chipboard as well as other papers. In asphalt-coated and laminated papers, the addition of paraffin wax to asphalt lowers its viscosity, permitting easier coating as well as improving its mp. Its use, however, was always limited by poor compatibility; the paraffin wax intended to 'bloom' out after coating. Tervan (349 or 449) added in required amounts with the paraffin wax corrects this and improves the water vapor resistance of the sheet."

At the recent San Francisco meeting of the American Institute of Chemical Engineers, P. M. Huemmer of the Union Oil Co. of California described a process said to be suitable for refining all grades of crude petroleum wax. Methyl ethyl ketone is used as the solvent in this process, which was first employed commercially in 1941 at Union's Oleum, Calif. refinery.

This plant has operated continuously since that time, supplying badly-needed high-melting-point waxes to the armed forces and to wax industries. Its fully refined waxes are said to be the only ones currently produced on the Pacific Coast. Wax uses include wax paper and cartons, protective coatings, candles, magazine color prints, carbon paper, paint for ship bottoms, and use in the processing of explosives.

It is only logical that petroleum wax should follow the trend of other petroleum products, which were first accepted commercially in their more or less natural (crudely distilled) forms but which now undergo all sorts of treatment (cracking, desulfurization, etc.) before they are marketed, often in admixture with modifying additives. Solvent refining and the use of additives provide types of wax which possess new and attractive commercial possibilities. It seems certain that much more work will be performed in these fields.

Meanwhile, the imminent commercial application in this country of the Synthine process, using natural gas, offers the intriguing prospect of the availability of waxes of entirely new properties. Such waxes, in addition to their possible direct uses, are excellent raw materials for the manufacture of synthetic lubricants and detergents, and it is highly likely that much research will be performed on them. It is in fields like this that the recently-acquired German data available from the Office of Technical Services will prove of considerable help.

[1] Klosky, S., *Chemical and Engineering News* 24, No. 17, 2342 (1946), "A Century of Oil-Shale Patents (1845-1945)."

[2] Lahey, R. W., *Chemical and Engineering News* 24, No. 17, 2402 (1946), "Packaging —Wax Flexibility Improved by Polybutene."

Fluidization Now Being Applied to Coal Coking

THE fluidization of solids technique is rapidly finding application in many fields and gives prospect of use in many more. Chief use at present, of course, is the fluid catalytic cracking of petroleum fractions. Another commercial application is the fluid catalytic oxidation of petroleum-derived o-xylene to yield phthalic anhydride. The possible fluid retorting of oil shale has been mentioned earlier in this article, and it is more than pertinent to recall that the Brownsville, Texas, Synthine plant of Cathage Hydrocol, Inc., will conduct its catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen by use of the fluidization technique. It is also to be noted that A. D. Singh and co-workers at the Institute of Gas Technology, Chicago, have conducted extensive research on the partial devolatilization of finely divided coal by fluidization.

In this process, "the solid is ground to minus 20-mesh size and fed into a stream of gas or steam which carries it into an externally heated retort at about 500° C. (932° F.); this retort contains a fluidized bed of char maintained at the desired level by a discharge outlet. There it is partially volatilized. The exit stream carries the product through a series of cyclone separators where the solid char is separated from the vapors, which subsequently yield tar, aqueous liquors, and gas."[3]

The low-temperature tar produced—15% by weight of the coal charged—should be "a fruitful source of phenolics. The yield of gas is 10% by weight; it has a heat content of 650-800 BTU per cu. ft., as compared with 300 for water-gas, and "is of a character suited for domestic as well as industrial consumption." Aqueous liquors are produced in 5% yield; these contain ammonia, ketones, organic acids, and other products.

The main product, of course, is the solid char, produced in 65-70% yield by weight. It "consists of granular, hollow spheres which are distinctly dustless. More than 50% of the sulfur has been removed; the char has a low volatile content which can be controlled within ± 1%, and it compares favorably with anthracite or 'smokeless' coals.

"The char made from coals containing 35-40% of volatiles can be mixed with binder to produce briquets containing 15% of volatile material. A char-raw bituminous coal blend equals Pocahontas coal in producing metallurgical coke and is potentially a source of synthesis gas comparable to natural gas, lignite, or coke. Removal of liquid and gas fractions lowers the hydrogen-to-carbon ratio, minimizing one of the problems in raw coal utilization where hydrogen combustion is responsible for considerable stack loss of heat."

The petroleum industry has long devoted a reasonable percentage of its income to research on the improvement and diversification of its products. Much of this has been engendered by the sharp competition which prevails in this field; much more is also due to the individual desire of certain companies to explore new fields which may prove profitable.

In the coal industry, little research has been performed except by those chemical companies which produce chemicals from coke by-products such as tar. A limited amount of research has lately been performed on the chlorination of coal and on its controlled oxidation, but again much of this has been done by chemical concerns. Coal hydrogenation and the coal-based Synthine process, certainly, are not the products of coal industry research.

This industry, however, is becoming aware that it produces a material which can be financially up-graded in various ways, and certain of its branches—the bituminous and anthracite industries—have established research institutes which are expanding their activities. Coal research is also receiving attention, as the work reported here attests, from the gas industry, and both public and private research institutes in coal-producing states are busily engaged in various studies. Finally, such federal agencies as the Bureau of Mines have long been concerned with coal utilization, and certain petroleum companies, as well as others, have interested themselves in coal hydrogenation and the use of coal as a raw material for the Synthine process.

As may be expected, coal and petroleum research are often highly interrelated, especially in the chemical fields, so that each industry must closely regard developments in the other. Coal and petroleum compete in many industries as sources of heat and power, and coal, if the cost of petroleum increases materially, may even compete as a source of synthetic liquid fuels, lubricants, waxes, etc. All of this makes the application to coal utilization of a petroleum-company-developed handling technique—fluidization—more than interesting.

Canada to Profit by Our Synthetic Fuels Research

NOW that the wartime fuel emergency has passed, the Canadian government is abandoning its active participation in synthetic liquid fuels research and, instead, "now plans to appoint a fuel research board representing both the government and private industry and assign to it the responsibility of following current research in the U. S. and of drawing up a new liquid fuel program for the Dominion."[4]

Parliament-approved plans for a $750,000 coal hydrogenation pilot plant will be postponed, since the Canadian government sees no economic future for "a synthetic fuels industry in eastern Canada based on high-cost Nova Scotia coal. The same outlook applies to the Pacific Coast region," especially since both regions have access by tanker to petroleum from the Gulf Coast, and South America.

The mid-continent region of Canada, however, may find its supply limited in the predictable future, so attention will continue to be given to natural gas, coal, and natural bitumen from Alberta tar sands. As reported some time ago, the Canadian government still plans to return to Abasand Oils, Ltd., the ownership of its plant at the McMurray Abasand tar deposits. The administration is "proposing to return to the company its land and mining rights on terms which will give the government an interest sufficient to assure a return of its net outlay of $1,545,000 should the project eventually prove a success."

The burden of future synthetic fuels research, apparently, will rest on the shoulders of U. S. private and government research groups, since Germany has more or less been eliminated from the picture.

Third Concern Making Acrylic Resins

THE production of acrylic resins, usually from petroleum chemical derivatives, has long been the almost exclusive possession, in this country, of du Pont and Rohm and Haas, so it is interesting to note that a third company has entered the field.

The Worne Plastics Corp., a new company, is producing acrylic resins in a recently-completed plant at Pinewald, N. J., whose capacity is shortly expected to reach 2,600,000 pounds per year. Capacity is almost equally divided between molding powder and cast forms.

One of Worne's resins is said to be similar to existing commercial preparations, but two of its series "are said to have superior values for certain properties. . .refractive index, heat distortion temperature, surface hardness (abrasion resistance), compressive strength, and lower water absorption."[5]

The acrylic acid derivatives used by Worne "are prepared from acrylonitrile (a petroleum derivative) in most cases,"; i. e., methyl acrylate is so produced. The special derivatives are prepared directly from ethylene by a series of reactions starting with interaction with phosgene; ethyl acrylate is the monomer produced.

Worne uses a new method of polymerization, which employs "the action of a high potential current" and controlled heat; less time is said to be required, and superior resins are obtained. The general-type acrylic resins are sold at prevailing prices, but the special resins sell for $1 to $2.50 per pound.

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[3] Anon., *Industrial and Engineering Chemistry* 38, No. 9, Suppl. p. 14 (1946), "Modernizing Old King Coal."

[4] Anon., *Business Week*, No. 890, 112 (1946), "Fuel Research."

[5] Anon., *Plastics* 5, No. 1, 84 (1946), "A New Acrylic."

Comeback Rumored For Steam Cars

FROM time to time rumors arise that some company or other was going to enter the automobile field with an improved steam-powered car. They have never materialized, yet they have never been considered with unadulterated mirth because the automobile industry knows full well that such a car might be built —but probably not at competitive costs.

In fact, "the falling off in demand for steam cars * * * was not due in any way to lack of engineering development; on the contrary, the last steam car models were 'over-engineered' if anything. These cars sold at prices ranging from $2750 for the runabout to just below $4000 for a seven-passenger limousine. Well built gasoline cars of the same size could be bought for about half that price, so the steam enthusiast had to 'dig deep' if he wanted to remain true to his convictions."[5]

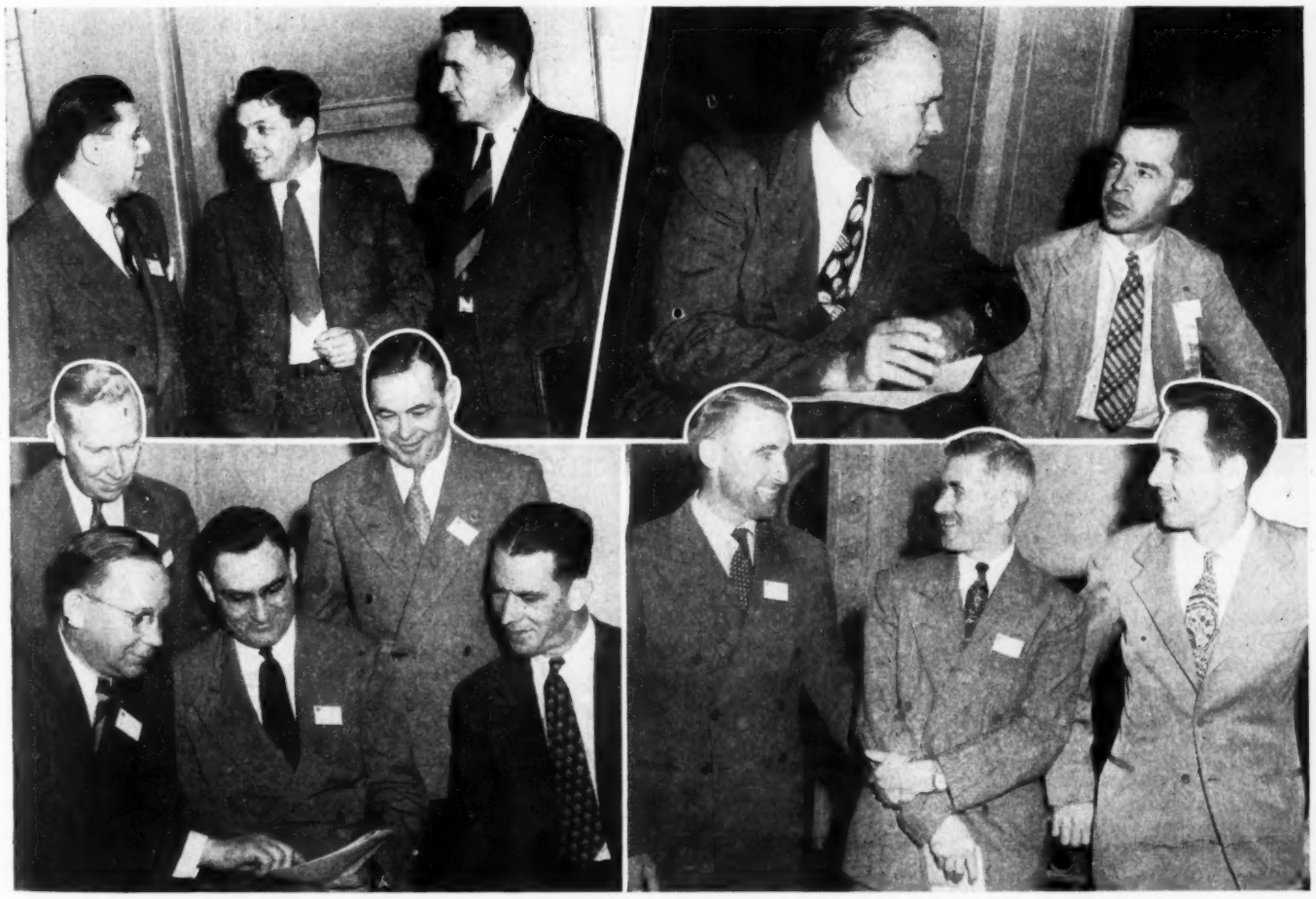
This last quotation is from a very interesting series of articles describing the "Rise and Decline of the American Steam Car Industry." They tell of the various cars of this type which were produced in the days when the steam car was a serious competitor for the internal-combustion, gasoline-powered automobiles, and an interesting account is given of the problems involved in vehicles of this type. Many of these had been solved by the time that the last Stanley steamer was made in 1923.

Joseph Geschelin, in calling attention to this series, remarks[7] that "we have learned unofficially of considerable new activity in this field. We have not yet put our fingers on it, but we understand that some prominent organizations are aiming at the development of a steam engine of advanced type for use in large vehicles such as buses." While this is only an unconfirmed rumor, Heldt, himself, has remarked[6] that "at least four or five companies did development work on steam buses * * * during the third decade of the century * * * but not one of them reached the production stage."

[6] Heldt, P. M., *Automotive and Aviation Industries* 95, No. 3, 20; No. 4, 30; No. 5, 34; No. 6, 38 (1946), "Rise and Decline of the American Steam Car Industry."

[7] Geschelin, J., *Automotive and Aviation Industries* 95, No. 6, 44 (1946), "Observations—Steam Engine Revival."

ASME Petroleum Section Meets in Tulsa



UPPER LEFT PHOTO: O. B. Schier, ASME staff, N. Y., talks over procedure with two authors: C. G. Chisholm, Haynes Stellite Co., Kokomo, Ind., center, and M. E. Holmberg, Phillips Petroleum Co., Bartlesville, Okla., right

UPPER RIGHT PHOTO: this candid shot caught E. B. Wist, Shell Development Co., San Francisco, settling a moot point with Irving Taylor, Lummus Co., N. Y.

LOWER LEFT PHOTO: a pre-refining session get-together of E. E. Kerns, Standard Oil Co. (Ohio), standing left, and P. E. Frank, meeting chairman, Sinclair Refining Co., N. Y., right, while seated J. O. Motsenbacher, Phillips Petroleum Co., Phillips, Texas, and David Stewart, Sinclair Refining Co., Marcus Hook, go over the paper to be given by M. Q. Colton, Ohio Steel Foundry Co., Lima, Right

LOWER RIGHT PHOTO: in this smiling group are, left to right, Louis M. Gasche, Fred E. Cooper, Inc., Tulsa; F. L. LaQue, International Nickel Co., N. Y., and Norman Zieqe, Phillips Petroleum Co., Bartlesville

SEE STORY COVERING INDIVIDUAL PAPERS, BEGINNING ON NEXT PAGE

New Mechanical Aids for Plant Operations Disclosed as ASME Petroleum Group Meets

By D. P. THORNTON, Jr.
Assistant Editor
PETROLEUM PROCESSING

New and improved mechanical equipment and materials used in the petroleum industry, and methods for their selection and maintenance, were disclosed at a meeting in Tulsa, Oct. 7-9, of the American Society of Mechanical Engineers. The meeting was sponsored by the Petroleum Committee of the Society.

Eighteen sessions were held and 35 papers presented. Subjects applying to refinery operation and maintenance included:

Factors in designing pressure vessels for high temperature service.

Means for relieving cavitation in operation of pumps.

Use of suspended wall linings for catalytic regenerator linings.

Improvements in hydraulic method of coke removal.

New developments in compressors for oil industry applications.

Salient points for refinery operators of some of the papers are reviewed below.

Factors in the Design of Pressure Vessels For High-Temperature Reactor Service

"Design of Pressure Vessels for High Temperature-High Pressure Service", by E. W. Jacobson and B. M. Wedner, Gulf Research Development Co., and T. G. Beckwith, University of Pittsburgh.

MANY conditions are encountered in designing vessels for high temperature-high pressure reactor service for which the ASME Code for unfired vessels does not provide a specific guide. The designer then must rely on past experience, following sound engineering principles summarized below and shown graphically in Fig. 1.

(1) The theoretical basis for determining wall thickness of vessel body should depend on service contemplated. For conditions involving steady temperatures and pressures, the maximum stress formula given by the Code should provide a safe, economical vessel. For cyclic or varying pressures and temperatures, dimensions nearer the maximum strain formula should be used in order to reduce effect of fatiguing conditions.

(2) Materials must be carefully selected to obtain maximum safety and economy. Much has been done by steel manufacturers to develop metals for use at high temperatures. Designers should take advantage of metallurgical experience when selecting materials for these reactors.

(3) Creep strength, differential expansion and thermal stresses must be given careful consideration.

(4) Good engineering practice must be followed. Refinement of details for successful design under ordinary service conditions require special attention under high temperature-pressure service. All conduit connections should be made through the heads if possible. Holes through the shell should be avoided. Good machine shop practice should be specified to obtain smooth inner surfaces with radiused edges. Supports should be placed so that concentrated stresses, due to weight of vessel, are avoided in already highly stressed parts.

(5) Type of closure selection will be determined by size and service of the vessel. Every part of the closure requires intensive design consideration with reference to kind of material, thermal expansion properties, unit stresses and tightening practice.

Major difficulties with the various types of closures and their merits are described. Under high temperature conditions, it is pointed out that particular care must be taken in choosing materials for component parts of compression-type heads to eliminate seal failure due to differential expansion. An example is given of a design that will fail from this cause where the arbitrary range of 650° F. or above temperature and in excess of 2000 psi is considered as the high-temperature-pressure range.

Ring joints for flanged closures are stated as being superior to the flat type joint both in actual practice and in laboratory tests. Bolt materials must have the same thermal expansion properties as the flange material; assembly should be insulated to maintain uniform temperatures throughout bolts and flange.

Discussion following this paper brought out that, in addition to external insulation, internal insulation often will permit keeping vessel skin temperature below process temperature. Circulation of cooling gases is of advantage. Possibilities of multilayer construction also were debated and considerable regret was expressed that a scheduled paper on this subject had been canceled.

A representative of A. O. Smith Corp. stated his firm had made multilayer vessels for high pressures, but had no commercial experience on this type of equipment for high temperatures also. Inner layer was built under prestressed conditions by wrappings under tension. He pointed out that temperatures above 700-800° F. would stress-relieve vessel, nullifying prestressing of wrappings in design. He also stated it was easier to build vessels to API Code because it has higher allowable stress than ASME Code. In vessels for 1000° F., 10,000 psi range and above, codes require factors of safety (or ignorance) resulting in impossibly monstrous vessels out of reason in cost and size. Considerable practical information on reducing these factors is needed.

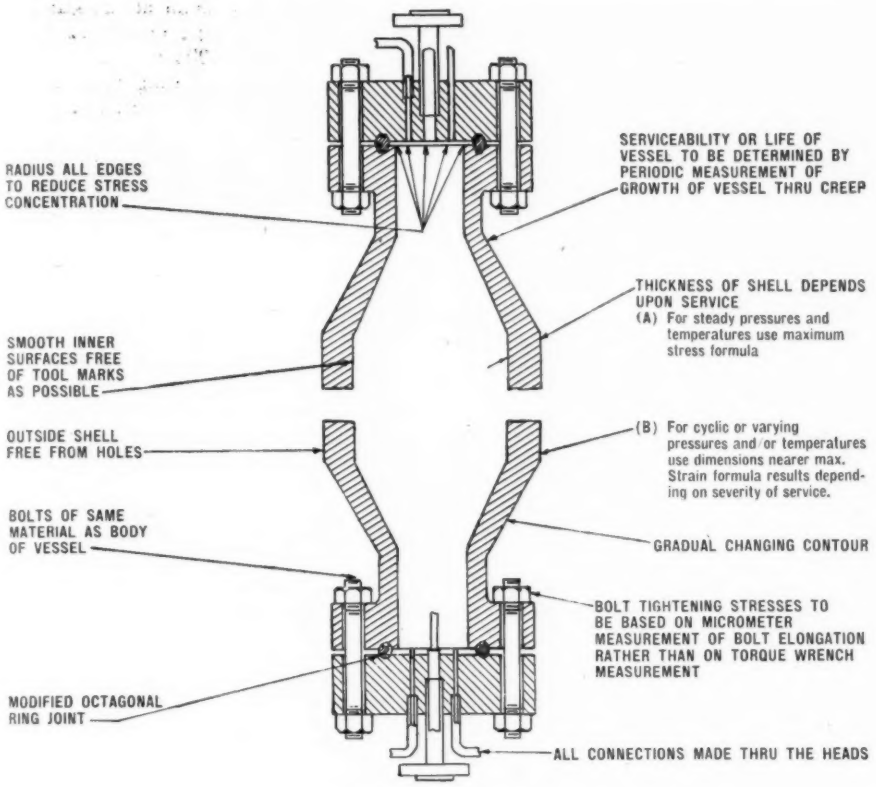

RADIUS ALL EDGES TO REDUCE STRESS CONCENTRATION
SERVICEABILITY OR LIFE OF VESSEL TO BE DETERMINED BY PERIODIC MEASUREMENT OF GROWTH OF VESSEL THRU CREEP
THICKNESS OF SHELL DEPENDS UPON SERVICE
(A) For steady pressures and temperatures use maximum stress formula
SMOOTH INNER SURFACES FREE OF TOOL MARKS AS POSSIBLE
OUTSIDE SHELL FREE FROM HOLES
(B) For cyclic or varying pressures and/or temperatures use dimensions nearer max. Strain formula results depending on severity of service.
BOLTS OF SAME MATERIAL AS BODY OF VESSEL
GRADUAL CHANGING CONTOUR
BOLT TIGHTENING STRESSES TO BE BASED ON MICROMETER MEASUREMENT OF BOLT ELONGATION RATHER THAN ON TORQUE WRENCH MEASUREMENT
MODIFIED OCTAGONAL RING JOINT
ALL CONNECTIONS MADE THRU THE HEADS

Fig. 1—Summary of requirements for flanged vessel design, high temperature high pressure reactor service

Hydraulic Methods Remove All Coke With Impact Jets; Cut Cleanout Time

"Hydraulic Decoking" by A. F. Welsh, Worthington Pump & Machinery Corp., Harrison, N. J.

MODERN hydraulic coke removal and transportation methods bear little resemblance to the old chain method in batch stills and later lacing with steel cables in the continuous coking chambers. There is more resemblance to the mechanical method in which a mechanical drill was combined with swinging weights, although it was dangerous to equipment to remove all coke in the chamber by this procedure.

The hydraulic method removes all the coke by means of high-impact producing jets incorporated in special boring and cutting tools. The "blades" on these cutting heads are not for cutting, but to protect jet nozzles. The tools are attached to the end of a hollow drillstem suspended from a swivel joint attached to a crosshead in the derrick; an air-motor in the swivel joint rotates the drillstem at the speed required.

Coke is removed in two steps: a hole is bored from top to bottom of the chamber, ranging from 24 to 48 in. in diameter depending on size of cutting tool. Next the stem is raised, cutting tool attached, returned to the bottom of the bed and raised in successive steps. Coke is cut into layers 6 to 12 in. thick, depending on size of chamber and bottom manhead.

Water is supplied to cutting nozzles by a high-pressure multi-stage centrifugal pump, usually driven by a condensing steam turbine since steam required seldom exceeds that needed to steam the coke chamber. Coke may be dropped into a gondola car, fines dropping through to a sump for settling and subsequent pumping to top of the gondola.

Where a coke pile is used, coke and water drop into a rail-mounted portable feeder and sizing car, which reduces large lumps to the maximum size suitable for pumping, and also regulates flow of coke to the sluice. Sluice conveys the coke to a sump by the cutting water. A "Hydroseal" pump, in a dry-pit adjoining the sump, pumps a coke and water slurry to the coal piles.

Where coke must be shipped immediately by truck or rail, a "Hydrobin" is installed, consisting of an elevated storage bin of conical construction which separates moisture from the coke. Classification is attained by installation of screens on top of the bin.

Volatile combustible matter (V.C.M.) is not a true indication of coke's resistance to hydraulic erosion; porosity is the true factor, but is difficult to estimate. Hence equipment must be designed on basis of experiment. Design requires known rate of coke removal necessary, a function of chamber diameter; coke character and time cycle. These in turn determine size of jet pump and driver as well as size of tools.

Majority of hydraulic decoking installations have been made on new equipment. One of the early installations was at Shell Oil Co.'s Wood River plant, which originally used the cable removal method. Installation of hydraulic methods reduced cleanout time 50% and allowed a 45% reduction in cleanout crew manpower, plus savings in cable and auxiliary materials.

Free Machining Steel In Oil Refineries

"Some Notes on the Use of Free Machining Steels in Connection with Petroleum Equipment," by M. E. Holmberg and F. A. Prange, Phillips Petroleum Co., Bartlesville, Okla.

THE free machining steels most frequently used in the petroleum industry are resulfurized Bessemer, open hearth, and stainless steels. Leaded brasses and bronzes sometimes also caused trouble in the failures prompting the paper.

Sulfur occurs in these steels as weak, brittle fibers of manganese and iron sulfides unable to transmit deformation. Phosphorus is present, making the matrix brittle or, if high, is present as brittle iron phosphide particles. In non-ferrous alloys lead is present as weak globules or stringers. These foreign phases have a marked effect on the physical properties, particularly transverse ductility, impact strength, fatigue strength and strain aging.

Practically, these properties mean that free-machining materials are unable to deform plastically under adverse conditions such as notched sections in bolts, pipe fittings, etc. In corrosive service the non-metallic phases markedly reduce corrosion resistance, particularly in the stainless steels. Primarily they should not be used where energy absorption may be required—where the piece may be subjected to overloading or plastic deformation in accommodating itself in the structure. For this type of service the free-machining materials are not much better than cast-iron.

It is not intended to give the impression there are no uses for the free-machining materials. They have a very large field, particularly where sheer mass and physical dimensions are prime requisites or where it is desirable to have a weak and readily replaced member in a structure fail and protect the remainder. Occasionally these materials are required for their superior galling resistance.

New Type Compressors in Modern Processes

"New Developments in Compressors for Petroleum Industry Applications", by J. N. MacKendrick, Clark Bros. Co., Olean, N. Y.

THE various improvements in types of compressors used in the oil industry were reviewed. Their characteristics appear in Table 1.

Axial compressors, primarily high volume for fixed operating conditions, have only been applied for Houdry plants at 40 psi maximum. Development for jet propulsion and gas turbines may be applied to commercial machines when demand dictates.

Centrifugal compressors, now high-capacity for fixed operating conditions, are primarily used for pumping large volumes of air from atmospheric to 15-20 psig and for freon refrigeration of ethylene, the butane-butylene fractions and propane. Some very large air compressors (up to 20,000 hp) for operation from a single turbine, together with oxygen, propane and mixed hydrocarbon gas machines, are being built for a plant in southern Texas.

These units have been installed with geared-up electric motors and steam turbines. None to date have been driven by internal combustion engines, due to cost of step-up gear and couplings. Possibility of using waste-heat gas turbines was advanced but this has not developed to point where it can be considered economic, even in the large sizes.

Reciprocating compressors have been most widely used by the oil industry. Combined engine-compressor units with gas diesel engines are under development, although these will run slightly higher in first cost and maintenance than with gas engines. Conventional diesel engines have been made where gas was unavailable and outside power expensive. Steam engines are not economical where gas costs over 10c per MCF and water exceeds 3c per bbl., on the average.

Motor driven compressors are normally used when a plant has excess electric power, or when cheap outside power is available. Pressures for these compressors range from vacuum to 15,000 psi, with a wide range of commercial experience in sizes up to 5500 psi. War experience has shown there is no reason to operate high pressure compressors at any lower speed than low pressure machines.

One of the larger developments of gas engine-driven compressors are 8 cylinder, 200 h.p. per cylinder, units of the same basic design as in former angle models up to 1000 h.p. Improvements include high-velocity cooling for power cylinders and heads, cast steel power cylinder heads and cast steel crowns on power pistons, a very heavy crankshaft with rearrangement of throws to eliminate critical speeds near operating range of the compressor. Previously, over 1000 h. p. models were horizontal units requiring heavy foundations and expensive installation. New units indicate operating and maintenance costs at least comparable with the large horizontal models.

Rearrangement of horizontal compressor cylinders so they are counteracted by a weighted scavenger cylinder has been developed for semiportable use. Unit consists of engine-driven compressor, starting unit, radiator, interstage piping, scrubbers and intercoolers mounted on a common skid. They are being used increasingly as small compressor installations.

A number of manufacturers are offering horizontally-opposed or pancake type compressors for hydrocarbon gases with horizontal, double-acting cylinders in sizes up to 2500 h.p.; sizes up to 5000 h. p. can be provided. Units are inherently well balanced and require comparatively small foundations.

TABLE 1—Characteristics of Improved Types of Compressors

Type	Positive Displacement	Normal Press. Range Lbs. Abs.	Normal Horsepower Range	Capacity Flexibility	Pressure Flexibility	Type of Gas Handled	Types of Driver Available
Axial	No	14.5-75	Above 2,000	Limited	Limited	High Gravity Usually Air	Turbine—High Speed Motor
Centrifugal	No	2-275	400-20,000	Limited	Limited	Any	Turbine—High Speed Motor
Fans—Propeller or Paddle Wheel	No	12-22	To 500	Limited	Limited	Air Usually	Turbine—High Speed Motor
Reciprocating	Yes	2-15,000	To 5,000	High	High	Any	Direct Connected Natural Gas Engine, Steam Engine, Diesel or Motor Drive
Roots or lobe type	Yes	3-30	To 2,000	Speed Change only	Moderate	Any	Coupled to engine or motor
Sliding Vane	Yes	5-100	To 600	Speed Change only	Moderate	Clean Dry	Coupled to engine or motor
Liquid Displacement	Yes	2-40	5-400	Limited	Moderate	Non Soluble	Coupled to engine or motor
Screw Type	Yes	100	3000	.....	.....	Clean Dry	.....

Evaluation of Petroleum Asphalts

"Asphalts and Their Evaluation for Commercial Use," by J. C. Roediger, Standard Oil Development Co., Elizabeth, N. J.

THE various methods by which petroleum asphalts are produced and the common tests are described, and the criteria for evaluating the results discussed. It is brought out that 1941 asphalt consumption in the U. S. was approximately 7,000,000 tons, of which 90% came from refining of petroleum. The largest consumption, 66%, was in asphalt paving; roofing was next with 24%, and waterproofing followed with 0.6%.

The eleven tests considered include: consistency (viscosity, penetration and softening point), susceptibility to temperature change, flash point, volatility, specific gravity, ductility, solubility, weathering characteristics, stain, shock resistance, and pliability.

Consistency determines temperature conditions required for use and application, and the hardness and pliability of the finished product. Temperature susceptibility measures the change in hardness with temperature; the greater the resistance to temperature change the better the asphalt can resist loading and shocks.

Flash tests are criteria necessary to determine the fire hazard in handling, shipping and processing. Volatility with straight reduced asphalts indicates degree of contamination with low boiling material; with blended or solvent separated products, it indicates boiling characteristics of the blending stocks or successful stripping of solvents.

Specific gravity finds its chief value in shipping calculations. Ductility measures the elongation or stretch, is used to determine adaptability for paving purposes and those undergoing vibrational stress. Solubility tests are run to determine presence of inert mineral matter, the amount of asphaltenes and to indicate whether the product has been overheated. Weathering tests are run to determine the outdoor weathering characteristics of the material; laboratory tests are as yet of little significance except in separating very good and very poor asphalts.

Stain tests are necessary to predetermine if the asphalt will meet requirements to maintain appearance of the manufactured product. Shock resistance tests are run where the product must withstand vibration or shock. Pliability tests are necessary for such products as wire coating compositions and paper lamination.

Advantages of Suspended Wall Linings For Catalytic Cracking Regenerators

"Suspended Wall Linings for Catalytic Regenerators and TCC Kilns," by H. O. Johanson, M. H. Detrick Co., of Tulsa.

MOST of the fluid catalyst cracking unit generators as well as many TCC Kilns now operating or being built are equipped with suspended wall linings. None has even been replaced with any other method of lining, and some monolithic linings have been replaced with suspended wall construction. Among advantages of suspended wall linings the greatest is that all tile are definitely locked in place mechanically. They are sectionalized to avoid cumulative loading, are engineered to take care of expansion and can take any desired thickness of insulation between lining and shell.

It is vital to install vapor seals in the insulation every three to five feet to keep pressure variance in the Fluid regenerator zone at a minimum and prevent intrusion of catalyst and damage to insulation. No tile wall can be erected under these pressure conditions that will prevent catalyst intrusion. Tile should be designed so lining has complete thickness of the tile; tiles should not have thin lips or lugs to break off.

Meehanite metal tile linings should be used at points of considerable wear (such as juncture between bottom cone and straight-wall sections of the vessel); Meehanite sleeves should be used at manhead and inspection openings. Meehanite metal linings should be used in pipe bends where excessive abrasion is encountered. Cause of trouble in suspended wall lined riser pipes, which subsequently had steel liners installed over the tile, has never been satisfactorily explained; that with standpipes was result of aeration and reduced by reducing aeration.

TCC kiln linings have given little trouble except at flue openings. This has been eliminated with suspended wall linings and by properly supporting and anchoring the tile immediately above and below the opening.

In discussion it was stated that use of "microspherical" catalysts are expected to reduce abrasion difficulties, and further help can be attained by designing piping layout to avoid areas of high turbulence. Newer installations will use lesser catalyst velocities also.

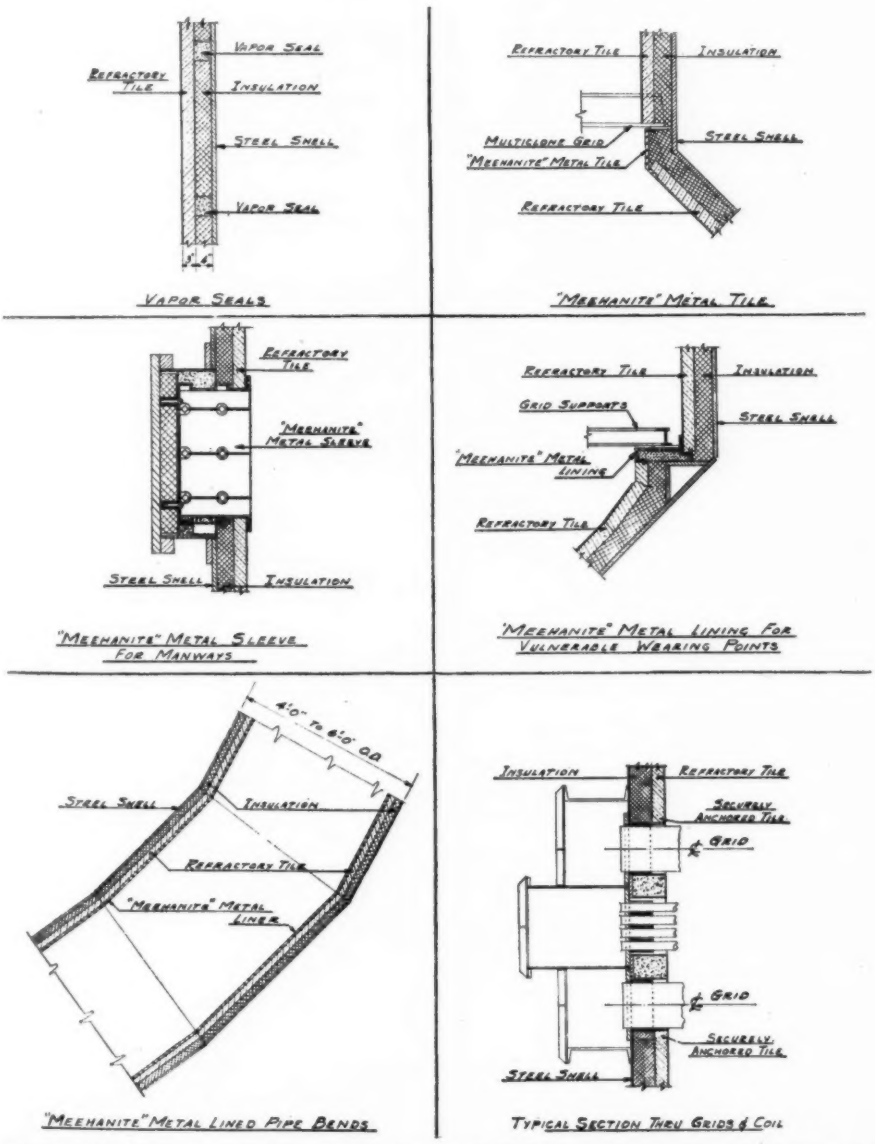


Fig. 2—Methods of installing suspended wall linings, with suggestions for special protection at "trouble points" in Fluid and TCC fluid cracking unit regenerators

Crude Oil Factor In Refinery Corrosion

"Corrosion of Refinery Equipment," by E. E. Kerns, Standard Oil Co. of Ohio, Cleveland

THE amount of corrosion in oil refining is fundamentally dependent on the degree of corrosivity of the crude and is largely determined by five factors, of which the greatest weight is placed on the first three. These are (1) hydrochloric acid evolution, (2) hydrogen sulfide sulfur, (3) mercaptan sulfur, (4) total chloride content, usually referred to as "total salt" when reported as NaCl, and (5) total sulfur content.

Hyrochloric acid evolution is a measure of the acid formed during distillation by hydrolysis of calcium and magnesium chlorides. "Total chlorides" and analytical determination of magnesium and calcium chlorides is not a reliable determinant. However, this figure is valuable since it is an indication of the tendency to plug heat exchanger tubes and the inorganic solid content of the residual product can be predicted from it.

Hydrogen sulfide and mercaptan sulfur are of about the same order of corrosiveness and are especially noticeable in high temperature equipment. Total sulfur content and relationship to corrosiveness of crude has not been definitely established However, high sulfur crudes are known to be more corrosive at cracking temperature than lower sulfur stocks.

Neutralization of acidity produced in crude distillation with ammonia is very effective, but suffers from the objections of high cost, plugging of towers and equipment and increased corrosion even with effective neutralization where consumption exceeds 7 lbs. per 1000 bbls. of anhydrous NH_3. It has the advantage of easy treatment for good distribution,

does not add to solids content of the residual material. Desalting prevents acid formation, has no measurable effect on corrosive sulfur content of crude.

Solid alkalies are considerably cheaper than ammonia, can corrode the usual solid copper alloy condenser tubes, are useful in overcoming objections to ammonia neutralization alone with particularly corrosive crude. Caustic soda, soda ash and hydrated lime are the cheapest alkalies. Soda ash gives no coking trouble, likewise lime; caustic soda is reported to promote coking.

Sohio's exchanger tubes vary from carbon steel to 18-8 stainless in resisting corrosion, while admiralty makes up the bulk of condenser and cooler tubes, inhibited to prevent dezincification. Cupronickel has proven quite satisfactory in special cooler applications. Highly corrosive condensing and cooling water definitely indicate need for bimetallic tubes, whose cost at present is regarded as unreasonably high.

Furnace tubes are largely carbon steel and 4-6% chrome 0.5 molybdenum. Tubes of 2% chrome 0.5% moly 1.25% silicon are quite satisfactory where low corrosion and high temperatures prevail. Where corrosion is too high for this alloy, 4-6% chrome 0.5% "moly" and 1.25 to 1.5% silicon is used, especially where oxidation is a problem.

Localized corrosion in towers and the like is met with alloy liners, including monel, 11-13% chrome and 18-8 chrome nickel either field installed or, preferably, plant fabricated where corrosion can be anticipated.

Cathodic protection is finding its way into refinery use, but sufficient time is lacking for definite evaluation. Nonmetallic coatings generally have temperature limitations unsuiting them to refinery operations, although some war-developed coatings appear to have interesting possibilities and are presently on test.

Never before have corrosion problems been so complex and the refiner can justify a considerable expenditure to combat it.

Methods for Determining and Relieving Cavitation in Pump Operations

"Pump Cavitation," by B. R. Walsh, Gulf Research & Development Co., Pittsburgh.

"CAVITATION" is often responsible for mechanical vibration and noise in some pump installations. Tests for determining this characteristic of pumps, factors leading to cavitation and means for avoiding it are described.

This paper considers cavitation as occurring when a pump is unable to deliver its normal rated capacity because full-flow pressure drop between liquid supply and actuating members of the pump exceeds the absolute supply pressure available to provide complete filling of the pumping members.

A pump may operate with some cavitation without producing objectionable vibration and noise. "Critical cavitation" is considered as beginning when the flow is reduced to 95% of rated delivery. When the difference between available supply pressure and lowest absolute pressure existing within the pumping members does not equal pressure drop of the inlet system for 95% flow, cavitation will commence even if liquid contains no dissolved gas and has negligible vapor pressure.

When available supply pressure is such that pressure in the pumping members for 95% full flow is reduced to the liquid vapor pressure, cavitation due to vaporization will commence.

Fig. 3 shows percent pump delivery vs. absolute pressure at liquid source for a system having liquid supply level with pumping members. Line *A* represents entry loss in the pump proper, *B* represents line *A* plus inlet line loss, and *C* is line *B* plus gas or air saturation pressure for a liquid with negligible vapor pressure. Line *D* is *B* plus vapor pressure of a liquid containing no dissolved air; *E* is the sum of partial pressures of liquid vapor and dissolved air plus line *B*.

Intersections of the 95% delivery line with the curves define the various conditions of critical cavitation. Intersections *J* and *K* are the critical "gas separation points" for liquids containing dissolved air or gas, *L* is the "vaporization point", *M* is the critical "system hydraulic failure point" where no dissolved gas is present, and *N* the critical "pump hydraulic failure point" where no dissolved gas is present in liquids of negligible vapor pressure.

For instance, if the system were a gathering line handling gassy crude having a vapor pressure of 3 psi, critical cavitation due to gas separation would occur at sea level supply pressure. This could be corrected by raising oil level about 3 ft. above the intake or by pressuring supply to 16 psi (*J* on curve). A 1.3 psi reduction of inlet line loss would also correct the condition.

If no gas were in solution, cavitation would not occur until pump absolute pressure reached point *L*, or about 7 ft. lift (14.7 − 10.1 ≐ 4.6 psi). Similar examples can be worked out for the other curves.

Remedies for cavitation were suggested as:

(1) Reduction of pump entry loss to absolute minimum by reducing centrifugal force losses through reduction of peripheral speed or clearance volume; use of side pockets (in a spur gear pump to reduce tooth loss); incorporation of pickup blades or ports and enlargement of inlet passage with elimination of turns and bends.

(2) Increase of pressure available at pump inlet by reducing inlet line loss; increasing liquid supply head; installation of a centrifugal booster (positive displacement pumps) and pressurizing supply tank.

(3) Elimination of entrained air (dissolved air also, if possible).

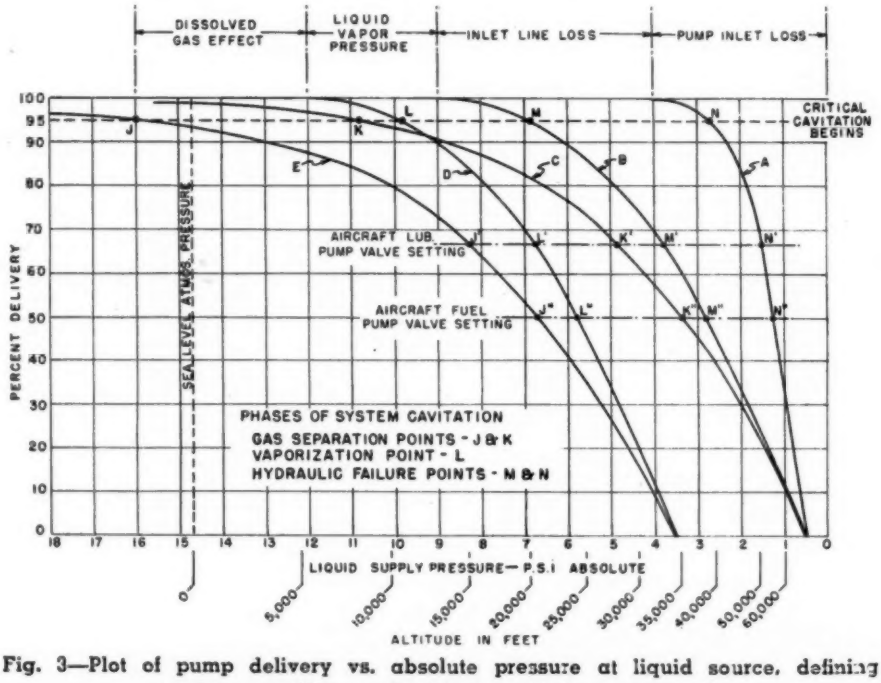

DISSOLVED GAS EFFECT
LIQUID VAPOR PRESSURE
INLET LINE LOSS
PUMP INLET LOSS
CRITICAL CAVITATION BEGINS
AIRCRAFT LUB. PUMP VALVE SETTING
AIRCRAFT FUEL PUMP VALVE SETTING
SEA LEVEL ATMOS. PRESSURE
PERCENT DELIVERY
PHASES OF SYSTEM CAVITATION
GAS SEPARATION POINTS - J & K
VAPORIZATION POINT - L
HYDRAULIC FAILURE POINTS - M & N
LIQUID SUPPLY PRESSURE — P.S.I. ABSOLUTE
ALTITUDE IN FEET

Fig. 3—Plot of pump delivery vs. absolute pressure at liquid source, defining various conditions of critical cavitation (see text)

MEMO:
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Control of Sulphuric Acid Corrosion

"Mechanical & Metallurgical Control of Sulfuric Acid Corrosion in Petroleum Processes," by E. R. Wilkinson, Standard Oil Co. of New Jersey, Baton Rouge, La.

THE five basic factors which influence sulfuric acid corrosion are reviewed; acid concentration, acid temperature, oxygen content of fluid, velocities and turbulence of fluid, and electrolytic action. These must be considered individually and collectively, as corrosion is not a direct function of the number of these factors present plus others less well known or entirely unknown; no single one is more important than another.

Effect of acid concentration is fairly straightforward, but for strength alone to be a controlling factor all other conditions must be ideal. For example, it has been shown that black acid from an operating unit is often less corrosive than white acid of comparable concentration. Temperature increases generally boost the corrosion rate. However, if the acid contains oxygen it may actually become less corrosive to some acids until temperature sufficient to expel the oxygen is reached, after which the corrosion rate again increases. Oxygen in sulfuric acid may increase its corrosive action on some metals, while it may decrease the rate of corrosion on others. Even saturation with air will greatly increase the corrosion rates on steel, for example.

Sulfuric acid frequently corrodes some metals only slightly, the resulting film protecting the metal against further corrosion; however, if velocities are sufficiently high or the turbulence great enough, the corrosion products may be swept away before the film is formed, or the film itself removed. Unfortunately there are no practical methods of applying laboratory data to field installations. Therefore, it is important to obtain accurate periodic data on critical velocities at such points in an operating system. If dissimilar metals are in close proximity or in contact, electrolytic action may be established which will displace the least noble of the two metals. Should they be used, close proximities should be avoided or those metals close together in the electromotive series should be chosen.

Corrosion in acid treating and alkylation plants is greatest in the equipment for reclaiming, separating and concentrating. In treaters, very little concentrated acid as such comes in contact with the equipment. Metals then should be chosen for long life in contact with 2-10% solutions in oils which may themselves be corrosive. Lead or copper-bearing alloys are suitable. Lead completely bonded to the steel is more satisfactory than loose linings. Muntz metal, everdur and monel give good service. If aeration is a factor and equipment will not permit use of lead, 18-8 chrome-nickel stainless, containing copper, molybdenum or silicon, or combinations thereof, should be used. Reinforced gunite linings have been used with some success. Brick linings require excessive maintenance.

In sulfuric acid alkylation, corrosion occurs at points of abrupt changes of direction. The best solution is 18-8 chrome-nickel stainless steel, with steels containing molybdenum of superior value.

In reclaiming systems, concentrated acid at low temperature is involved from the operating unit to separators, beyond which the acid is much weaker and at higher temperatures which render it very corrosive. Carbon steel is generally satisfactory until the acid reaches the separators. After separation, lead has been used successfully except for its low strength. Hastelloy D, duriron, worthite, Aloyco 20, monel, everdur, red and ye'low brass have been used with varying success for valves and pumps, the first two being very satisfactory.

In the separators, the same selections are involved, except that Hastelloy D valves, while corrosion resistant, are poor from an operational standpoint because of their design. They are unsatisfactory where coke is encountered. The copper bearing alloys, such as monel, are poor in 60% acid at 275° F. Hastelloy D, corrosiron, duriron, lead, acid brick and carbon have been employed in the concentrators, depending on the exact conditions at various points.

Operating experiences are summarized in Table 2, indicating suitability of various materials for specific applications. Laboratory data cannot be greatly relied upon and past experience, plus continual field tests, is the best guide in the selection of materials to withstand sulfuric acid corrosion. Actual inspection records are of great importance in any program to combat corrosion.

TABLE 2—Summary of Material Suitability for Specific Applications in H_2SO_4 Service, From Operating Experience Data

Operating Process..	Treating	Alkylation	Acid Reclaiming, Separating, & Concentrating				
Acid Concentration.	2-10%	88-98%	40-60%	40-60%	75%	90%	
Acid Temperature..	100°F	35°F.	200°-240°F.	240°-275°F.	275°F.	150°F.	300°-325°F.
PIPE & VALVES							
Carbon Steel	Bad	Very Good at Low Velocity	....	....	....	Very Good at Low Velocity	....
Lead	Very Good	....	Very Good	Good	....	....	....
Corrosiron or Duriron	....	....	Very Good	Very Good	Very Good	....	Very Good
Hastelloy D	....	....	Good	Good	Very Good	....	Very Good
Monel	Good (1)	Bad	Good	Very Poor	....	....	....
Everdur	Good (1)	....	Fair	Poor	....	....	....
Red Brass	Good (1)	....	Fair	Poor	....	....	....
Yellow Brass	Fair (1)	....	Fair	Poor	....	....	....
18-8 Chrome-Nickel	Fair (2)	Very Good	....	....	....	Very Good	....
18-8 Chrome-Nickel Moly.	Good (2)	....	....	....	....	....	....
Worthite	....	....	Fair	Poor	Very Poor	....	....
Aloyco 20	....	....	Good	Fair	Fair	....	....
LININGS							
Lead	Very Good	....	Very Good	Good	....	Poor	....
Acid Brick	....	....	....	Good	Good	....	Good

.... Indicates no experience. (1) If not aerated. (2) If aerated.

Wear Resistance Of Gray Irons

"Wear Resistance of Gray Irons", by F. G. Sefing, The International Nickel Co., Inc., New York.

GRAY iron is noted for its superior resistance to wear because of its graphitic structure. It is used in high duty applications such as piston rings, cylinder walls, lathe ways, plug valves, sealing rings and the like. Some of these irons, however, have marked differences in wear resistance.

Properties required for wear resistance include minimizing deformation by requiring high compressive strengths (120,000 to 200,000 psi) reducing corrosion by use of inhibitors or those irons having high resistance to the corrosives in-

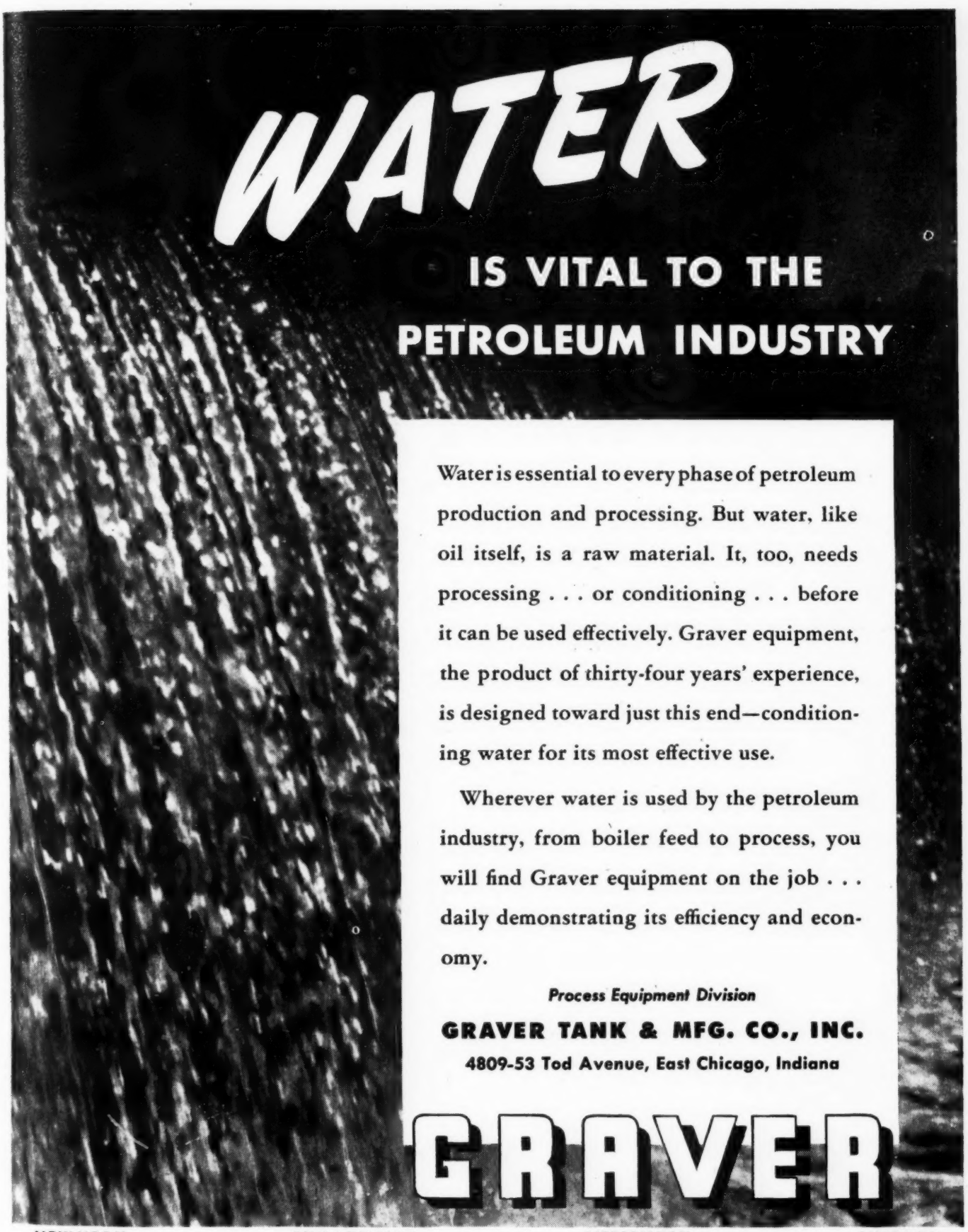

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TABLE 3—Classification of Gray Iron Structures for Wear Resistance

A. Ni-Resist, a fully austenitic gray iron with no massive cementite. Hardness 135-170 Brinell.
B. Acicular structured alloy gray iron with small amounts of austenite. 220 or more Brinell.
C. Refined and completely pearlitic matrix with A. F. A. Type A graphite. 200-320 Brinell.
D. Coarse pearlitic matrix with no free ferrite.
E1. Pearlite with a small amount of free ferrite matrix with A. F. A. Type A graphite. 160-190 Brinell.
E2. Abundant ferrite matrix with A. F. A. Type A graphite. Less than 150 Brinell.
F. Some massive cementite or phosphide matrix with any form of graphite. Plain gray iron over about 230 Brinell.
G. Ferrite matrix associated with dendritic graphite, A. F. A. Type D or E graphite. 180 or more Brinell.

volved. Abrasion can be minimized by using high tensile iron with maximum toughness. Scoring, galling and seizing can be minimized by selecting those irons with metal structures having maximum resistance to welding, adhesion or wringing. Presence of graphite in gray iron provides anti-galling characteristics.

Gray iron structures are classified in order of decreasing wear resistance and according to structure in Table 3 suggested as a guide in selecting proper structures for service required.

For extreme resistance to wear and corrosion, such as in engine liners, chemical pumps, and valve parts; structure A is recommended. For wear involving high contact pressures, use structure B. Structure C is recommended for moderate metal-to-metal wear, such as in pump liners and piston rings. Structures D to G are satisfactory only where demands for resistance to wear are of low order. Good modern foundries can readily supply the structure specified.

Study Copper Alloys In Sulphur, Water

"A Study of the Corrosion of Copper Alloy Condenser Tubes," by N. W. Mitchell, Chase Brass & Copper Co., Waterbury, Conn.

THE principal primary causes of corrosion are reviewed to bring out the point that most copper alloys in refinery and natural gasoline plant service fail by stress corrosion cracking, corrosion fatigue, and impingement corrosion. The results of corrosion, as they are visible on the metal are described. Hitherto unpublished data secured from extensive corrosion tests are given which indicate the comparative resistance of the various alloys to attack by sulfur and water are given in Table 4.

Alloys tested were Antimonial Admiralty, 72 Cu, 1 Sn, 0.05 Sb, 26.95 Zn; Admiralty, 71 Cu, 1 Sn, 28 Zn; Red Brass, 85 Cu, 15 Zn; 20% Cupro-Nickel; 30% Cupro-Nickel; Aluminum Brass, 76 Cu, 2 Al, 22 Zn; Muntz metal, 60 Cu, 40 Zn; and straight copper.

TABLE 4—Corrosion of Copper Alloy Condenser Tubes
(Values are per cent of original tensile strength lost due to corrosion)

	Types of Alloys							
	Antimonial Admiralty 72 Cu, 1 Sn, 0.05 Sb, 26.95 Zn	Admiralty, 71 Cu, 1 Sn, 28 Zn	Red Brass, 85 Cu, 15 Zn	20% Cupro Nickel, 80 Cu 20 Ni	30% Cupro Nickel, 70 Cu 30 Ni	Aluminum Brass, 76 Cu, 2 Al, 22 Zn	Muntz Metal, 60 Cu, 40 Zn	Copper
I. Attack predominantly by Sulfur:								
4 mos. in vapor line, top of vacuum tower	2	2	63	66	..	..	..	..
4 mos. in vapor to oil exchanger	19	17	27	29	..	..	..	..
4 mos. in gasoline vapor line	7	8	23	27	..	20	..	..
3 mos. in vapor stream, top of bubble tower	62	77	88	52	..	100	79	..
5 mos. in vapor side, crude still partial condenser	9	6	7	7	..	7	..	..
5 mos. in oil vapor stream leading to condenser	38	31	79	33	..	43	..	..
1 mo. in bubble tower vapors, 386° F.	4	4	16	..	..	..	..	..
4 mos. in stabilizer reboiler vapors, 386° F.	4	4	60	..	..	..	..	..
4 mos. in stabilizer overhead vapors, 180° F.	5	5	5	..	..	..	..	..
3 mos. in gasoline vapor line to condenser	8	6	10	8	..	..	..	..
8 mos. in vapor side, unit condensing gasoline	3	4	5	..	8	4	..	..
11 mos. in unit condensing heavy gasoline vapors	9	10	14	..	15	10	..	..
19 mos. in vapor side, flash tower overhead condenser	4	3	3	..	2	3	..	..
6 mos. in condenser shell, water and gasoline condensed	13	14	23	10	..	13	..	..
6 mos. submerged in water-gasoline condensate	8	8	10	4	..	6	..	..
5 mos. in caustic side of stream to caustic exchanger	39	..	100	15	..	..	..	..
3 mos. in treated gasoline vapors, 300° F.	48	55	44	27	..	63	..	..
9 mos. in experimental condenser, gasoline vapor	16	12	22	7	..	10	..	..
8 mos. in reflux condenser	6	11	10	10	11	..	..	..
5 mos. in vapor line to condenser	15	25	39	13	..	44	44	..
3 mos. in high stage condenser—bottom center	17	22	49	..	23	..	..	..
3 mos. in high stage condenser—top center	20	17	22	..	30	..	..	..
High pressure fractionating column, Dubbs unit:								
1.4% Sulfur, 121 days at 698° F.	..	..	100	..	..	..	53	..
1.4% Sulfur, 115 days at 680° F.	16	13	100	..	..	..	12	..
1.4% Sulfur, 26 days at 599° F.	6	7	100	..	100	7	7	..
1.4% Sulfur, 27 days at 545° F.	4	2	100	..	100	16	1	..
1.4% Sulfur, 27 days at 491° F.	2	2	100	..	57	10	1	..
II. Attack predominantly by Water:								
38 days, vapors from alum evaporator	47	96	44	44	..	..	..	..
15 mos., corrosive water	2	0	1	0	..	3	..	..
5 mos., cooling water to condenser	8	5	5	4	..	4	..	..
4 mos., condenser-box water, 125° F.	2	1	0	..	..	..	..	..
3 mos. in cooling water to condenser	5	3	2	3	..	..	..	..
5 mos. in condenser-box water	4	12	3	0	..	2	34	..
12 mos., water side, flash tower overhead condenser	33	50	51	..	39	53	..	..
Special case, Benzol, chlorinated hydrocarbon, and steam at 160° F.	36	45	48	14	..	..	..	48
Special case, specimens immersed in carbon black paste 20 days	2	..	2	..	2	..	..	9

Shield Over Section of Cooling Tower Basin Speeds Up Removal of Oil from Water

By RAY ELO, Process Supt., Sohio Petroleum Co.

ONE of the problems that is frequently encountered in cooling systems is the one of removing quantities of oil from the surface of the cooling tower basin. Quite often skimming arrangements are provided, but because of the agitation of the surface by the falling water, the oil and water do not separate and, consequently, oil which should be removed by the skimmer merely goes 'round and 'round the system.

In one plant, separation of oil and water has been facilitated to a very great extent by building a shield over that section of the cooling tower basin next to the pump suction, so that the falling water is diverted to the side of the basin and a dead or quiet area of water is formed under the shield. This allows the oil to rise to the surface, where an adjustable skimmer drains off excess oil.

The shield is made of corrugated sheets laid over a wooden framework and sloped so that water falling onto the sheet runs down and into the basin at the side opposite the pump suction. Fig. 1 shows a sectional side view of the shield. All details of the wooden framework are not indicated, but these can be designed to fit the particular conditions encountered.

The skimming trough consists of a length of 8-in. standard pipe with 90° sections cut out as indicated in Fig. 2, and with one edge of the cutouts finished. The trough is pivoted at either end so that by rotating it the finished edge of the cutouts can be brought just far enough below the liquid level in the basin to form a weir over which the oil layer can flow. Oil removed through the trough flows into the overflow junction box and is removed through the overflow line.

The use of an adjustable skimmer helps reduce tower blow down, besides aiding in the quick removal of oil from the basin. In practice it has been found that with this set-up oil can be almost eliminated from the system in a few hours and with little or no labor. Prior to its installation days were often required, even when considerable labor was used.

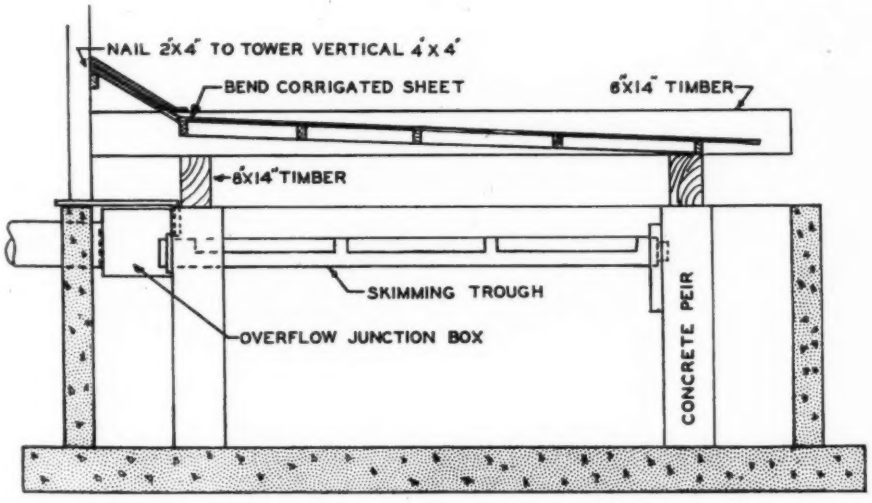


Fig. 1—Sectional side view of the shield of corrugated sheets built over a cooling tower basin to prevent the falling water from agitating the contents of the basin and interferring with oil separation. This shield diverts the water to the edge of the basin, leaving a calm area in which the oil can separate and be removed

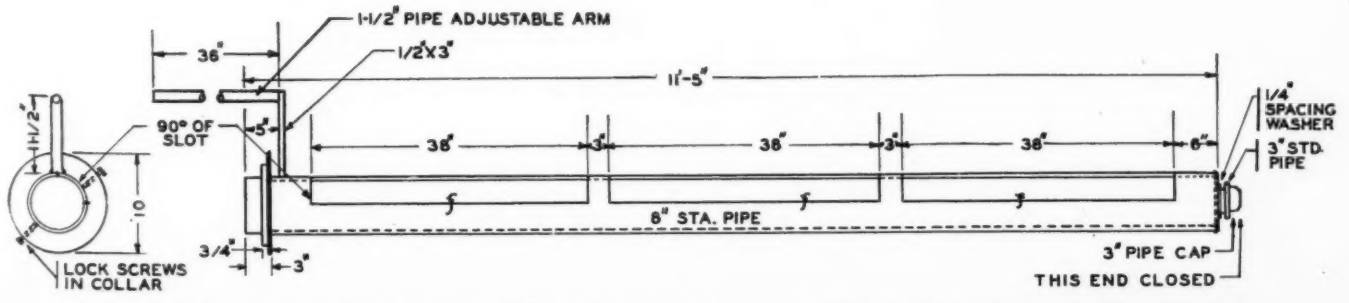


Fig. 2—Details of adjustable skimming trough used to remove oil from water on a cooling tower basin

Jigs Simplify Precision Grinding of Faces On Gate Valve Wedges and Seat-Rings

A SIMPLE jig to permit precision grinding of gate valve wedges by attaching them to the regular face-plate of the grinder, and another allowing grinding of valve seat-rings, has been developed by J. H. Murray, a Phillips Petroleum Co. employee at Kansas City.

Faces of wedges in gate valve become worn from use until they will not seat tightly and leak, or they may become damaged by foreign matter lodging between the face and the seat-rings when the valve is closed. Sometimes they are eroded by grit and scale carried along in the fluid, especially when the poor practice of using gate valves for throttling flow is followed. Because they are relatively expensive, it is often cheaper to repair than replace wedges on large valves.

Frequently all that is necessary is to grind them off to a new and true surface, lapping to perfect fit by hand after installation. Most valves contain provision to compensate for refinishing by allowing longer stem travel, which seats the wedge deeper in the body. In other cases, where the face is scored so deeply as to have penetrated the hard surfacing of the trim, the wedge still can be made serviceable by building up with weld metal, followed by grinding and lapping.

Grinding the faces is complicated by the angle with which the two opposing faces incline to one another, and because the two must be properly oriented to the center line of the wedge-and-stem assembly. These factors require careful setting-up on lathe or grinder for each face and every time the job has to be done. If a jig is used, its taper must be complementary to that of the wedge, so the finished article will seat properly in the valve.

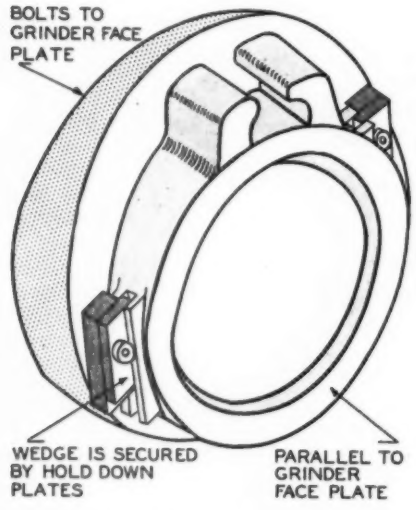


Fig. 1—Jig to be attached to face plate for grinding faces of gate-valve wedges. Set-up assures proper orientation of faces on opposing sides of wedge

The work side of the jig is taken as the reference plane, the side to be attached to the face plate being tapered as shown in the drawing, Fig. 1. The wedge is bolted securely to the jig by hold-down plates which fit in the guides of the wedge. Only one side of the wedge is repaired at a time, the untouched face serving as a reference plane also.

With this jig setting up is simplified to the extent of requiring only placement on the face-plate of the grinder and bolting the wedge into place on the opposite side. By drilling several holes along a diameter of the jig, it can be adapted to take most any size of gate valve normally handled in the shop.

The other jig facilitates grinding surfaces of screw-type seat-rings for gate valves, and is simpler than the first because it does not have to compensate for taper. It consists of a circular plate, as shown in Fig. 2, carrying a thread into which the seat-ring is screwed, the plate in turn being bolted to the face-plate of the grinder. Adaptors, which screw into the basic jig, can be made to permit grinding 2, 3, 4 and 6-in. rings, in addition to the 8-in. size.

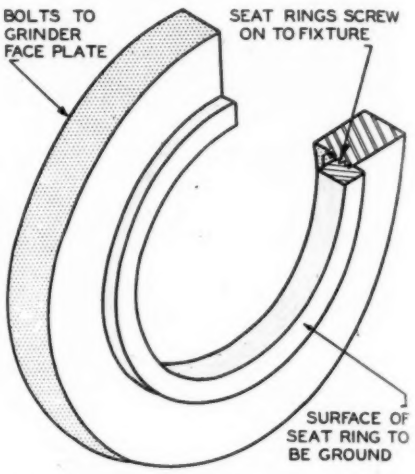


Fig. 2—Screw-type seat-rings can be screwed into this jig, for easy resurfacing of worn or damaged rings

This method permits the shop to build up the surface of worn or pitted rings with suitable weld-metal, and then grind them to finish dimensions. If desired, alloy trim can be added in this manner.

Periscope Inspects Reactor Linings at 1000° F.

A PORTABLE viewing device which can be used to inspect the refractory linings of vessels at temperatures around 1000° F. is now being used by Sun Oil Co. in the butadiene reactors at their Toledo refinery. It eliminates the long waiting period previously necessary when inspections were made by a workman entering the reactor.

The device, designed and built by Lewis Bartow, electrician foreman, is an illuminated, heat-insulated periscope. A sheet metal housing at the lower end contains a 150-watt seal beam headlight and a plane mirror, each of which is protected by a piece of ½ in. thick pyrex glass. An eyepiece containing a double lens of thick glass at the upper end of the cast iron pipe completes the device, as shown in Fig. 1. The viewer can be held in a 1000° reactor. It is about 8 ft. and can be carried by 2 men.

In use, the disc of flat sheet steel seen resting on the two drums in Fig. 1 is placed over the open manhole on top of the horizontal cylindrical reactor. The viewer is attached to the crossbar by means of a simple yoke. Rockers placed about 10 inches from the center of the crossbar support the entire assembly on the plate. Thus the viewer can be swung back and forth or rotated about its vertical axis, permitting a quick inspection of all parts of the interior of the reactor.

Fig. 1—Portable viewing device for inspecting refractory linings of butadiene reactors as used by Sun Oil at Toledo refinery

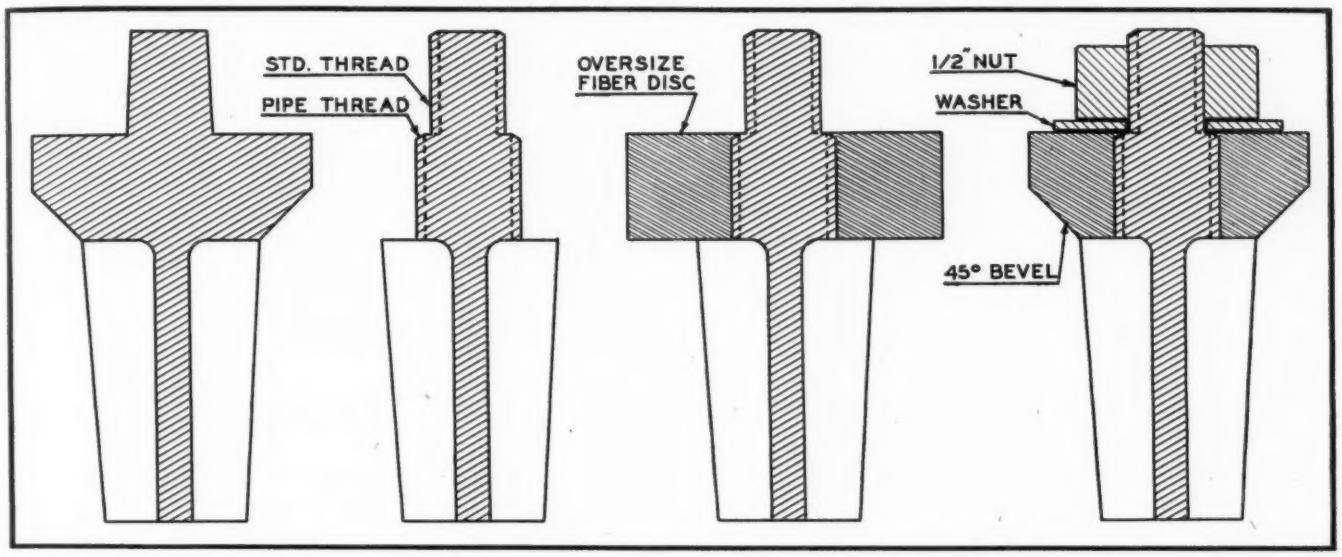


Fig. 1—Steps necessary to renew brass poppet-type valves with fiber disc seats, which give 5-7 months life, instead of the usual one month. The original brass valve (left) is turned down and threaded (second from left) and then fitted with an oversize fiber disc (second from right). The disc is then turned down to proper diameter and seat, and held in place with a washer and nut (right). It can be renewed again by turning down the disc to a smooth seat

Use of Fiber Discs Increase Valve Life 700%

By CLARENCE MINIUM, Oil City, Pa.

THE life of poppet-type valves in the boiler feed water pumps at the Independent, Pa., refinery of James B. Berry & Sons Co. has been increased to as much as seven months by replacing the usual brass seats with fiber discs. Previously the valves had to be renewed or replaced every month.

Water used in the plant comes from nearby Oil Creek. It is used at a temperature which normally runs about 180° F., and in the past considerable trouble has been experienced with the valves in the pumps becoming eroded and channeled.

Old brass valves which had been refaced several times are used to form the bodies for the fiber disc valves. The old valves are chucked up in an engine lathe, turned down to remove the old seat, and threaded, as indicated in Fig. 1. Oversize fiber discs are screwed onto the theads up to the shoulders of the valve wings, and then turned on the lathe to the proper size and the necessary 45° seat. The discs are held securely in place by a washer and nut.

When the fibre disc valves become worn, they can be renewed by merely turning down the disc to a smooth seat. After being renewed in this manner about three times, the discs usually have to be replaced.

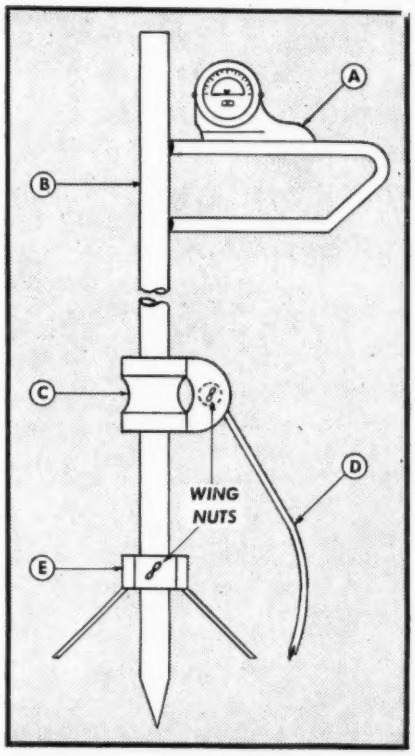
These fiber disc valves have also been used with good success in ammonia pumps.

Compact Instrument Lays Out Pipe Spud Cuts

A TIME-SAVING instrument for laying out cuts to be made in a pipe for any size spud up to the diameter of the pipe, entering at any angle, has been developed by a welder in a large Gulf Coast refinery. Every welder has his "pet" way of doing this job, general practice being to use templates and have one available for each size of spud, pipe and angle.

The invention combines three commonly-used instruments into a single apparatus which is small, compact and easily carried in the welder's kit: a bevel protractor, center punch, and compass. The instrument, shown in sketch below, works as follows:

The desired angle of attachment for the spud is set on the bevel protractor "A," and when adjusted so it is level, sets the instrument at that angle with the pipe. The center-punch rod "B," now can be struck with a hammer to center-punch the segment of pipe to be scribed. The compass, "C," is brought into position, the adjustable arm "D," carrying a soapstone tip for marking the cut, is adjusted to the required radius and the segment scribed. The combination of items "A," "B" and "E" are used to establish the segments on the pipe at any angle; an inexperienced layout man can use the instrument without difficulty, due to its simplicity.



Instrument for scribing segments in laying out cut for spud attachment to pipe at any angle. "A" is a bevel protractor for leveling instrument at any specified angle; "B", a ⅜ in. center punch rod; "C", a ball-bearing bushing for moving "D" up, down and around rod "B"; "D" is an adjustable arm attached to "C" and carrying a soapstone tip for marking spud cut, and "E" is an adjustable "A-frame" for center-punching spud cut

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Control Program Insures Follow-Up on Prescribed Plant Water Treatment

Full value to the refinery and natural gasoline plant of the prescribed chemical treatment for boiler feedwater and cooling water is frequently lost through failure to consistently carry out the various treating steps. A plant control program is a means to overcome this difficulty. The organization of such a program is described.

Responsibility for the plant water treatment should be placed with the control program supervisor, and operators should be trained in their functions in the treating program. Regular check-ups should be made on both raw water and the treated water after use, and these supplemented by more complete laboratory analyses, to determine promptly when changes in the treatment are required and the type of equipment necessary.

In some instances, areas between slats in sides of cooling tower offer a good place for microbiological fouling and thus create a special water treating problem

By D. P. THORNTON, Jr.
Assistant Editor
PETROLEUM PROCESSING

COOPERATION of plant personnel is often a more important factor to the success of a water treating program in refineries and natural gasoline plants than the specific chemical treatment prescribed.

It is well recognized that the condition of the water used for cooling purposes, in processing, and for steam generation has an important bearing on plant efficiency. In spite of this, however, the industrial water is generally accepted by the operators without question as to its condition. Even where chemical treatment is utilized, it is too often done on a hit-or-miss basis. These conditions can be overcome, experts in this field emphasize, through a well organized water treating control program.

After the required treatment is determined and the facilities installed, a control program provides the supervision needed to insure that treating is carried on as scheduled. It provides for testing the untreated water regularly to determine promptly when changes take place it its characteristics which may require altering the treatment. It also calls for routine tests on used waters to check the efficiency of the treatment.

The well organized control program also includes enlisting the cooperation of the operating personnel to insure that changes in processing methods, installation of new equipment, or other pertinent conditions, come to the attention of those in charge of water treating, in advance of their adoption if possible. If this is neglected, damage to equipment may result.

The plant laboratory has an important function in the program in addition to routine water analyses. Among other services, when new equipment is to be installed it works with the process and engineering departments to insure if possible that suitable water is available from the start of operations.

The following incident illustrates what may happen when a water treating control program is not set up in the plant. A water chemist was consulted after the cylinder head of an engine at an isolated pump station cracked from overheating caused by excessive scale formation in the water jacket. Examination of the raw water indicated it had only a slight scale-forming tendency under normal engine operating conditions. The scale proved to be a type which should not have formed from the raw water.

Investigation disclosed that the operator on his own initiative, and with the best intentions, was adding a compound he had heard was useful in preventing engine jacket scale. The chemist recommended the use of untreated water, explaining that the addition of the treating compound in this case had unbalanced the water chemically and made it a bad "scaler."

The best way to assure adequate control in a water treating program is for one man to be designated as solely responsible for all water treatment. Depending on the size of the plant, this individual may have other responsibilities, or he may need several full time assistants. He need not be a trained chemist but he must have sufficient technical background to fully understand the treating program and its importance in efficient plant operations. In small plants the supervisor may do all the treating himself and make his own tests.

The plant laboratory usually is ade-

quately equipped and staffed to run the necessary tests and quite often has the responsibility of recommending treatment. However, professional water specialists often are consulted for recommendations based on the plant laboratory's tests.

For best results, personnel who do the actual treating should be under direct control of the water treating supervisor, although in many plants this is not practicable. In the latter case, the men should be thoroughly acquainted with the problem and the recommended program. They must understand their own key importance in the program and the necessity for following instructions carefully.

Should the treaters be non-technical personnel, as is ordinarily the case, explanations should not be technical but nevertheless must be complete. The treater's duties should be made as simple as possible and arranged to cause the least interference with his other responsibilities. He should not be required to make complicated control tests. Usually simple, indicative tests can be developed by the supervisor which, while not as accurate as laboratory examinations, will be sufficient for a day-to-day guide as to treating.

Automatic Proportioner Helpful

Frequently some type of automatic proportioning device can be installed which will reduce the treater's duties to keeping the hopper full and the device running. Necessary adjustments and control tests may be made by supervisory personnel, thus constituting a double-check on treatment.

A case in point is the situation at one plant, where the pumphouse operator was responsible for treating cooling water. The procedure was to dump the chemical into the cooling tower basin. Unfortunately, chemical was stored some distance from the tower and the operator had to measure out the day's supply, carry it to the basin and dump it. Quite often he failed to measure the supply accurately and sometimes he forgot it entirely. The results were tolerable but not good, for the operator usually erred on the side of "too much."

The plant owners finally were convinced the installation of a proportioning device would provide better treatment and use less chemical. After a year's use of the device, which was installed close to the chemical storage and accessible to the operator as he came on duty, it was found the proportioner had paid for itself and returned several hundred dollars "profit" from reduced chemical costs. For the first time also, the treating program was giving the designed performance.

Another important fact often lost sight of by operating personnel is the effect of summer on the efficiency of a cooling water system. Atmospheric humidity often is high, limiting the ability of evaporation to cool the water to "normal" levels.

Trouble was experienced at a temporary pipeline station in keeping the engines running on very hot days. Operators thought it was caused by scale deposition. They called in a water chemist, who found the engines so arranged that hot air from the radiators was being recirculated. Recommended treatment consisted of a rearrangement of the engines to reduce circulation. If that did not eliminate the trouble, the treating expert suggested construction of wind tunnels to each radiator to prevent all recirculation of air. In any event, he said, there was nothing wrong with the water. The first suggestion did the trick.

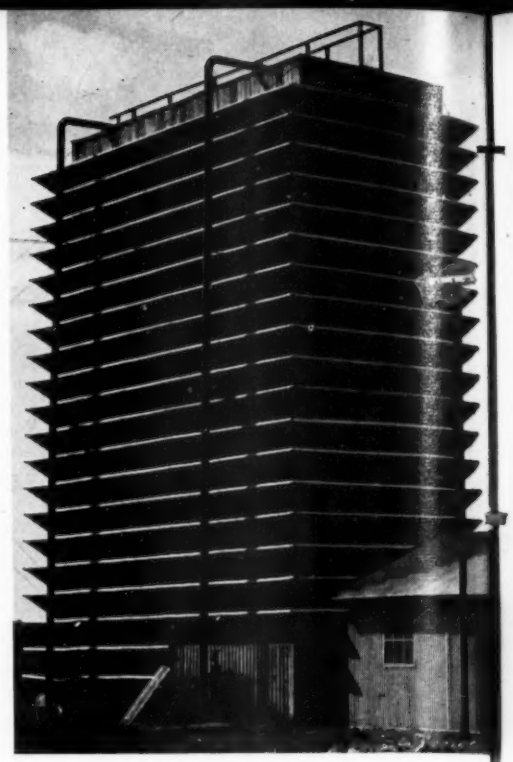
Chief Chemist Responsible in One Plant

A moderate sized refinery in the southwest maintains close control over its water treating program with a small group of men. Full responsibility rests with the chief chemist and all treating is done by the laboratory staff. Several commercial treating processes are used on the two raw water sources available, depending on whether the water is used for boilers, as a coolant or for processing. A full time chemist makes the various control tests necessary in the field and directs the activities of the treaters, who have some technical background.

The laboratory, in addition to making various precision tests, is constantly experimenting with new treatments and equipment. It also works with the process and engineering departments where trouble develops or new equipment using water is to be installed. The laboratory does not perform mechanical maintenance on water-treating equipment, pumps, towers and the like. Neither is it responsible for poor results from overloaded equipment.

Some refineries place water-treating responsibility with the chief engineer, who may delegate the authority to one of his assistants. The laboratory generally performs all tests except those for immediate control, which are made by the yard men on cooling water and by boiler tenders for boiler feed water. For boiler water the field tests usually consist of simple titrations with methyl orange and phenolpthalein indicators for alkalinity, along with soap hardness and chloride determination for blowdown control. The necessary additions of chemical are determined by reference to a chart provided by the supplier of the commercial treatments used. Blowdown is adjusted to maintain recommended alkaline chloride concentration.

Cooling water is commonly treated with a glass type phosphate, immediate control tests being the determination of increase of solids concentration over that originally present ("times concentration"). The laboratory runs detailed tests weekly. In one plant, where glass type phosphate is also used in boiler



Typical atmospheric cooling tower installation in a natural gasoline plant. House at right protects pumps. Flat-bottomed basins, on which towers like this are frequently mounted, are difficult to clean, must be scooped out with shovels

water as a softener, the boiler tenders run their own phosphate tests every few hours to keep concentration to a predetermined level through regulation of blowdown and addition of chemical.

In many plants liaison between process operations and the water-treating supervisor is maintained through daily staff meetings of plant department heads. Here every sort of operating problem is discussed in round table fashion, the plant superintendent or his assistant acting as chairman.

Investigation Pays

Investigation of water supply, plus careful control of treating, frequently pays off in a striking manner. At a natural gasoline plant recently built in Oklahoma, the water supply was to be derived from two wells, drilled fairly close together. Normally, it would be assumed they would produce the same water, but a mineral analysis revealed definite differences. As indicated in Table 1, water from Well No. 1 is low in hardness and contains considerable natural alkali. The flow from Well No. 2, on the other hand, is a typical Oklahoma hard water, low in natural alkali.

Water from the first well is entirely unsuited for boiler water because of its initially high alkalinity, which would tend to increase dissolved solids content and might lead to boiler failure through caustic embrittlement. It is desirable for cooling water as is, however. The hard water from Well No. 2, on the other hand, is much more desirable for boiler use.

In actual practice, it was decided to

TABLE 1—Analysis of Untreated Plant Water Coming from Two Adjacent Wells

Test Description	Analysis Grains per Gallon Well No. 1	Well No. 2
Silica	0.443	0.584
Iron & Aluminum (as oxides)	0.116	0.140
Calcium Carbonate	1.868	6.796
Calcium Sulfate	....	1.154
Magnesium Carbonate	1.379	7.573
Alkali Carbonates	13.658	....
Alkali Sulfates	2.284	1.084
Alkali Chlorides	1.700	8.160
Alkali Nitrates	Trace	Trace
Alkalinity (as $CaCO_3$):		
With Phenolpthalein	1.1	None
With Methyl Orange	16.4	15.9
Soap Hardness	3.5	16.8
pH	8.4	7.8
Total Incrusting Solids	3.806	16.427
Total Non-Incrusting Solids	17.870	9.499
Total Soluble Mineral Solids	21.676	25.926
Organic Matter	Trace	Trace
Losses, etc.	0.228	0.253

combine the supply from the two wells, treating with a mixture of a glass type phosphate, such as sodium hexametaphosphate, or the pyrophosphate, and an organic peptizing agent, such as tannin. Boiler feed water makeup is taken from the cooling pond, mixed with returned condensate and injected without further treatment. Admittedly this is not the best practice, since "good" water is lost through evaporation and concentration of total solids is apt to be high. The method was used here to reduce expense and facilitate operations.

The mechanism is as follows: The glass type phosphate inhibits the deposition of carbonates as scale, holding them in solution. The organic material, which acts as a peptizing agent, will keep in suspension any carbonates which might drop out of solution. When the treated water reaches the higher temperatures of the boilers, the glass type phosphate reverts to the normal form, where it acts as a water softening agent and not as a scale inhibitor. The organic material continues to act as a peptizer, keeping any sludge in such fluid condition that it will be easily removed during blowdown.

Treatment Control Set-up

In this case, strict control of treatment and frequent examination of boiler water is very necessary in order to maintain proper alkalinity in the boiler. Control has been set up to provide that boiler water shall have 10 to 20 grains per gal. of alkalinity, as determined by titration against standard sulfuric acid using phenolphthalein as indicator, and hardness is in no case to exceed 0.5 grain per gal. with the standard soap test. These values are maintained by neutralizing hardness of No. 2 Well Water with the alkali of Well No. 1, plus the previously mentioned chemical treatment.

Treating costs at this plant are reported as 3c per 1000 gal. of cooling water makeup. No cooling system blowdown is required, boiler feedwater makeup taking care of the requirement. Boiler blowdown is controlled on the basis of alkali chloride concentration in the boiler not exceeding 8 times the concentration in the makeup water, or 4 to 6 times that in the makeup-plus-condensate mixture.

Table 2 shows a check test on boiler water, raw feedwater and feedwater-plus-condensate, raw feedwater being taken direct from the cooling pond, at the same plant. Reversion of the glass-type phosphates to the normal type, whence they act as softening agents, is very apparent by comparing hardness figures of Column 2, raw feedwater, with the zero-hardness boiler water in Column 1. It is also apparent that blowdown has kept alkali chlorides in the boiler water within the specified range. Alkalinity is above the maximum limit and indicates that the blend of well waters could have been adjusted to include more of the hard effluent from Well No. 2. However, total alkalinity in the boiler water sample is not regarded as excessive.

Blowdown Important

In general, failure to realize the importance of blowing down the cooling water system is a common reason why water treating programs are unsatisfactory, specialists point out. Operators lose sight of the fact that some water is inevitably lost by evaporation and this may quickly build up a concentration of total solids to the point where no known treatment will keep them from precipitating as scale. This is especially true in locations where the raw water is initially high in minerals. Theoretically concentration could reach a point where there would be all mineral and no water.

All too frequently also, cooling tower basins are not designed for easy cleaning, which may result in pick-up of muck in the pump suction for later deposition in plant equipment. A sloping basin, with blowdown located at the lowest point and pump suction well above this level, will save hundreds of man-hours in keeping atmospheric, forced and induced draft cooling tower basins clean, plant men point out. With such a basin, the tower need be shut down but a short time to permit hosing muck into the blowdown for disposal rather than the lengthy process of scooping it out with shocks.

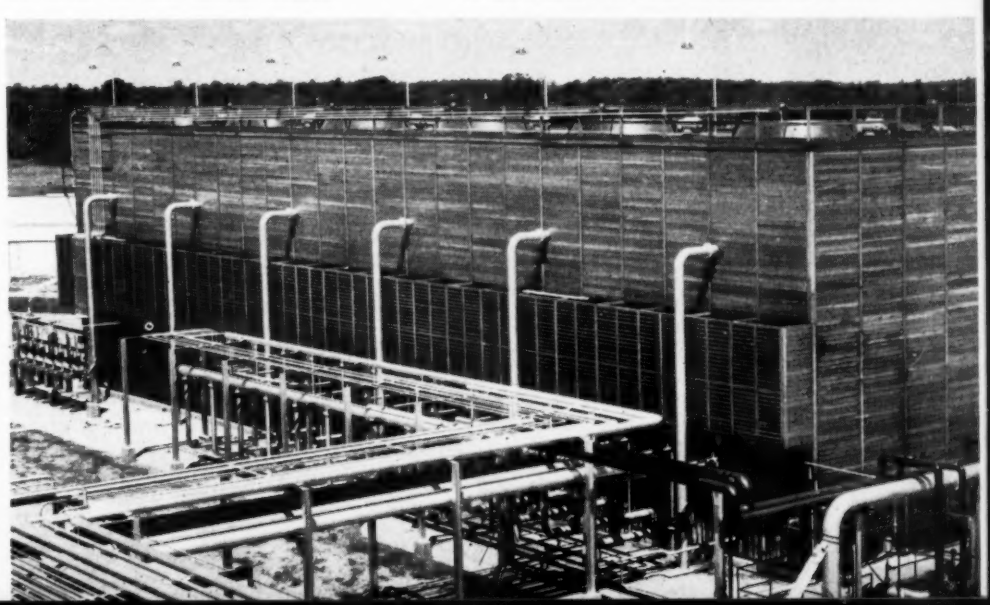
In existing towers with flat basins, some relief from muck entrainment may be realized by locating the suction intake as high above the bottom as possible but still low enough to avoid "grabbing air." One water treating specialist now is engaged in developing a nozzle for use on the end of a suction hose which he believes will eliminate necessity of scooping muck from the basin with shovels. Experimental models,

TABLE 2—Tests on Combined Well Waters Following Internal Treatment

Test Description	Analysis Grains per Gallon Boiler Water	Raw Boiler Feedwater	Boiler Feedwater*
Alkalinity (as $CaCO_3$):			
With Phenolphthalein	29.4	1.7	1.0
With Methyl Orange	36.4	12.7	6.2
Soap Hardness	0.0	8.5	3.3
Alkali Chlorides	12.5	3.0	2.2

* Consists of raw boiler feedwater (taken from cooling pond) plus added steam condensate.

A cooling tower of the so-called forced draft type. This tower, which cools water at the rate of 7000 gpm. is known as an induced draft type, which has superseded in recent years the forced draft type. Blowers are placed in top of structure, may be seen as flat metal domes *(Photo courtesy The Hudson Engineering Corp.)*



which look much like the nozzle of a vacuum cleaner, are said to have proved successful in oil company trials and the nozzle is expected to be commercially obtainable sometime in 1947.

As an illustration of the importance of blowdown in the water treating control program: A water treatment firm had an emergency complaint to the effect that, while at first the recommended program had quickly relieved a bad scale situation, cooling system scale-up later was worse than it had been with untreated water. Investigation showed that proper amounts of chemical were being added as specified but tests were not being run on cooling water, because plant operating conditions and water supply had not changed since the program was recommended. The cooling water system had not been blown down because the yard operator "could see no need of it." The lack of a water treating control program was demonstrated.

Tests Show No Scaling

By contrast, tests had been run on boiler water and the prescribed treatment followed carefully, with the result there was no scaling evident. Using the latter as "proof of the pudding", the water specialist was able to demonstrate as much justification for routine cooling system blowdown and regular tests as there was at the boiler house. Accumulation of total solids in the cooling water from lack of blowdown, he explained, had reached such a point that no possible treatment could prevent scale formation.

Another serious type of industrial water treating problem which occurs exclusively with cooling and air-conditioning systems is microbiological fouling. This is the result of algae, protozoa and diatoms — microscopic animal and plant life—growing in the water and on surfaces in pipes and cooling towers as well as in heat exchangers. Temperatures below those encountered in boilers will not kill them, and for control (complete eradication is the exception rather than the rule, according to professional water treaters) they must be treated with antiseptics.

Fouling from this source is said to be most troublesome in a belt ranging from the Gulf Coast north to approximately mid-Kansas, although it prevails throughout most of the U. S. In this belt not only are temperatures high over a longer period, but generally higher humidities prevail than in more northern and eastern climates.

Many methods have been advanced for controlling microbiological fouling, but there have been numerous objections to most. Liquid chlorine is an excellent germicide, but is said to cause corrosion if used in too large doses. Also the chemical is lost when the water is aerated. It constitutes a hazard in handling it and requires special injection equipment. Still, many regard it as one of the best treatments for this water condition. Copper salts, such as the sulfates, are good but must be used intermittently because algae particularly develop immunity to them. Sodium salts of chlorinated phenol (carbolic acid), such as sodium pentachlorphenates, chromates, permanganates, amines, sodium hypochlorite, and others have been used with success.

From a practical standpoint, if a system is biophysically fouled, care must be used in any treatment to prevent detachment of large chunks of the slime, particularly in systems where exchanger tubes are small and located a considerable distance from the cooling tower and pond. Where tubes are large and the distance relatively short, less care is necessary because there is less surface exposed from which the slime can detach, hence less possibility of plugging tubes, or lines.

Where "shock" or intermittent treatment is to be employed, especially in systems having small tubes some distance from the pond, great care must be used in applying concentration sufficient to kill the growth but to avoid detachment of large chunks of material. The safest way treating engineers say, is to mechanically clean the system if it is badly fouled, then use a poisoning agent either continuously or in frequent shock dosages.

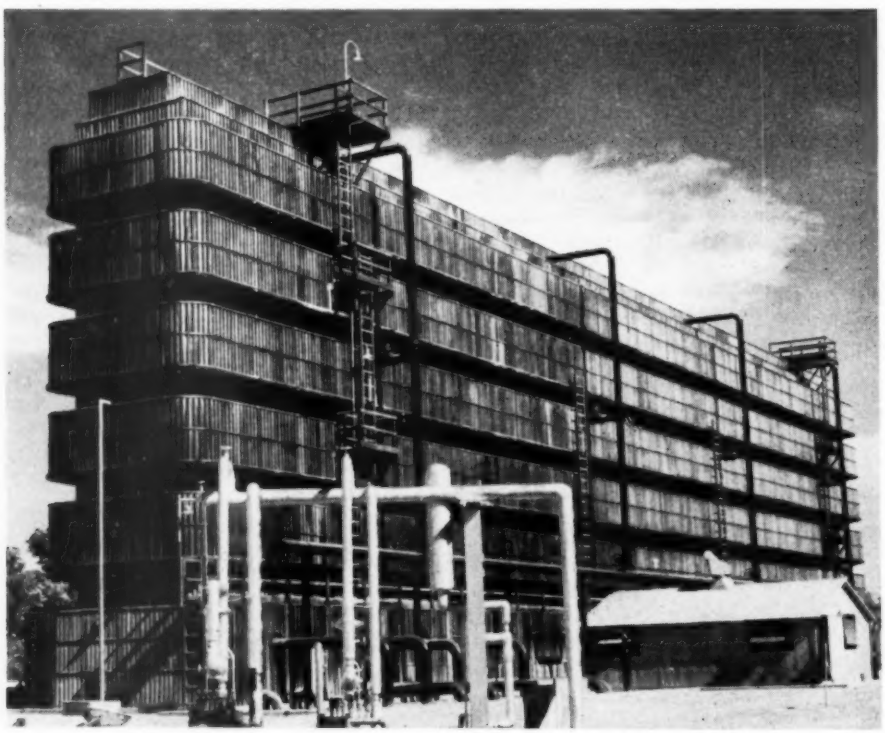
New Microbiological Fouling Controls

There are at least two new methods of controlling microbiological fouling which show considerable promise in the existing experimental stage. One is the use of ultraviolet light, the other a hormone-containing paint. Neither is available commercially as yet.

Ultraviolet light has been used for some time to sterilize air in homes, hospitals and factories. For cooling water irradiation a wavelength of 2735 Angstrom units, which differs from that used for air sterilization, has been found valuable. It suffers from the objection that, like the medical wavelengths, ultraviolet light will cause blindness and will blister the skin. Research on this method is continuing.

The second is patterned from the use of DDT-containing paint as insecticides and plant sprays containing hormones in agriculture as weedkillers. Paint doped with kerosine or light oil bases containing hormones known to be deadly to algae, protozoa and diatoms has been tried by several major oil companies for coating cooling tower surfaces, particularly those areas which ordinarily are not touched directly by the water, hence are unaffected by the usual biological killers.

The method suffers from the objection that air-borne silt is trapped by moist surfaces not in contact with falling water, and forms a film whereon the microscopic plant life grows—out of contact with the killing hormone. Only feasible solution as yet developed is the obvious one of periodically hosing away the "insulating" film.



Atmospheric cooling towers of this type are especially designed for minimum spray loss (which augments routine blowdowns) in areas where water is scarce. Such systems require careful control of total solids concentration in the water to avoid scaling, in addition to any chemical treatment which may be used

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Patent Trends in Petroleum Refining

By Peter J. Gaylor

Patent Attorney and Editor "The Technical Survey"

Developments disclosed in the patents reviewed below include:

Process for manufacture of high VI synthetic motor oils, by Carbide and Carbon Chemicals Corp.

Novel method for adding alkyl radicals to organic compounds.

Manufacture of hydrogen peroxide from propane.

New means for control of temperature of reflux liquid.

Synthetic insecticide and fungicide oils.

High VI Synthetic Lubs

A BRITISH patent application (25,-614/45) bearing the convention date of Dec. 13, 1944, was recently opened for public inspection and may be the basic application covering the new line of synthetic lubricating oils developed by Carbide and Carbon Chemicals Corp. The specification is some 24 pages long and contains 13 claims.

The invention is concerned with engine crankcase lubricants which are synthetically produced. One lubricant covered is a composition consisting essentially of a mono-hydroxy 1,2-polyoxypropylene fluid, which is the addition product of a monohydric alcohol with 1,2-propylene oxide, together with a small amount of an addition agent adapted to reduce consumption, maintain a substantially uniform viscosity during use, retard or repress corrosive conditions, and eliminate objectionable odor.

An addition product of butanol and 1,2-propylene oxide is prepared in the following manner:

About 360 lbs. (4.9 mols) of distilled *n*-butanol and 14.5 lbs. of powdered sodium hydroxide were charged into a clean, enclosed reactor equipped with an agitator, from which oxygen was removed. This mixture was heated to 110° C. and 1,2-propylene oxide was introduced to the reactor in which the temperature was maintained at 100° C. to 110° C. The rate of addition of propylene oxide was such that the pressure was maintained between 30 and 35 psig. Reaction was continued until approximately 2600 lbs. (45.2 mols) of propylene oxide was introduced.

At the end of the reaction, 150 gal. of water were added and the alkali catalyst was neutralized by the addition of 21 lbs. of carbon dioxide. After neutralization, an additional 200 gal. of water were added along with 150 gal. of benzene. This mixture was agitated to permit the extraction of sodium carbonate from the product. After standing an aqueous layer containing this salt was decanted.

One portion of the layer containing the product and the benzene was charged to a stripping still and heated, so that after 14 hours the maximum temperature was 156° C. at an absolute pressure of 12 mm. of mercury. About 40 gal. of distillate were removed and 135 gal. of product were recovered. A second portion of the product layer was heated in a stripping still for a period of 9 hours to a maximum temperature of 185° C. at an absolute pressure of 28.5 mm. of mercury. Approximately 80 gal. of benzene were removed as a distillate and 135 gal. of residue products were recovered. Some of the benzene was discarded in the aqueous phase and the residue was free of benzene.

The residues from the two distillations were blended and filtered through a filter press containing a filter aid. The final product amounted to 2785 lbs.

Addition of Alkyl Radicals To Organic Compounds

SEVERAL interesting patents recently issued to Shell Development Co. (U.S. 2,396,206 and 2,396,217) involving a novel method for adding alkyl radicals, particularly methyl groups, to organic compounds. The process centers around the use of di(tertiary alkyl) peroxides, and particularly di(tertiary butyl) peroxide, the preparation of which is the subject of a number of Shell patents.

Di(tertiary butyl) peroxide is a surprisingly stable compound. It does not explode when ignited, but merely burns with a sooty flame. When dropped on a hot plate held at 250° C, it also will not explode. This compound begins to decompose at about 190° C. and decomposition is complete at about 200° C. When it does decompose, it liberates a free methyl radical, which can recombine with other radicals present, as can be seen from the following reactions:

$$(CH_3)_3COOC(CH_3)_3 \rightarrow 2(CH_3)_3CO—$$

$$(CH_3)_3CO— \rightarrow CH_3— + (CH_3)_2CO$$

$$CH_3— + (CH_3)_3COOC(CH_3)_3 \rightarrow$$

$$C_2H_6 + (CH_3)_2CO + (CH_3)_3CO—$$

In the above reactions the dash (—) denotes a free radical.

When the peroxide is decomposed in the presence of other compounds, it is possible to cause a reaction to take place between the latter and the free radicals liberated. For example, when ethylene is present when the peroxide is decomposed, butane and some hexane are produced. With propylene, a yield of 25% (on the peroxide) of isopentane is produced. With isobutylene, neohexane, neopentane, tertiary amylenes and isopentane are obtained. With allyl chloride, 2-chlorbutene-1, 1-chlorbutene-2, and chlorisopentane are formed.

Di(tertiary butyl) ether may be produced by oxidation of isobutane in presence of hydrogen bromide (2:2:1) at about 160° C., using gaseous oxygen.

The reaction has a number of commercial applications. For example, a patent pending process employs such a decomposition reaction on reactive textiles, such as cotton, to obtain appreciable permanent waterproofing presumably through the formation of a surface layer of the cellulose ether.

Hydrogen Peroxide

IT IS well known that hydrogen peroxide is formed during the oxidation of some organic and inorganic compounds. Organic peroxides are also formed. However, the commercial production of hydrogen peroxide by such means has never been adequately demonstrated.

A close approach in this direction is indicated by U.S. Patent 2,376,257 issued to Shell Development Co., in which propane is used as the raw material. A continuous process is described, wherein propane and oxygen (9:1) are passed

through a reaction at 200° C., the mixture being introduced at the corrosion-resistant surface thereof, whereupon the mixture is conducted to a reactor zone of 440°-500° C. for 3-10 seconds, and the products are cooled rapidly.

The yields of hydrogen peroxide obtained at various reactor temperatures are shown in Fig. 1.

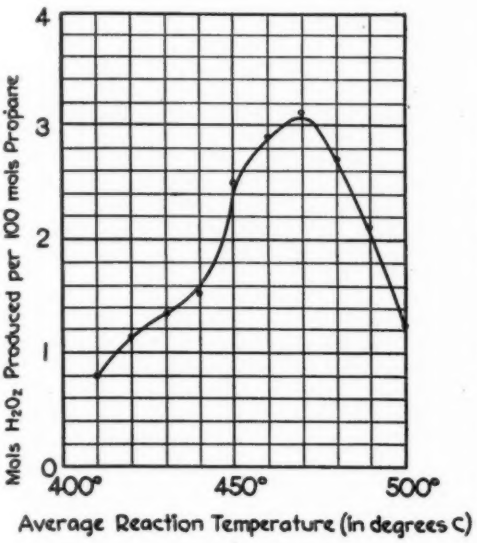

Fig. 1—Yields of hydrogen peroxide from propane at various reactor temperatures

Fractional Distillation

IN THE fractionation of vapors containing different constituents such as hydrocarbon vapors, it is usual practice to control the temperature at the top of the fractionating tower by controlling the temperature of the reflux liquid introduced into the top of the fractionating tower. Water is used for cooling the reflux liquid. Very often the water used is salt water, and this results in corrosion, particularly at the higher temperatures.

In its U.S. 2,404,677, Standard Oil Development Co. discloses the operation of a fractionating tower in which the reflux liquid is withdrawn from the tower at a constant rate and passed in indirect heat exchange with fresh feed and another medium to recover heat. Then the partially cooled reflux liquid is passed to another heat exchanger where cooling water is used. Corrosion and vaporization of cooling water are thus greatly minimized. Heat is removed from the tower by taking a side-stream of hot liquid, cooling this liquid outside the tower, and then reinjecting it. This cooling is done by heat exchange with the fresh feed.

Fig. 2 illustrates one type of system employing this technique. The feed in line 10 is preheated in heat exchangers 16 and 24 through which passes reflux from line 64. The temperature of the reflux liquid to be returned by line 136 is adjusted by by-passing the heat exchangers by routing reflux through line 88. Final cooling of the reflux is done by passing it through water cooler 94. The final temperature of the reflux may be controlled by by-passing cooler 94, using line 98. By-pass through this line at valve 96 is controlled by thermostatic control 68 at the vapor outlet line of the tower.

Synthetic Insecticides

IT HAS been common practice to use a naturally occurring petroleum fraction boiling in the range of 350°-800° F. in the preparation of insecticides and fungicides. Fly sprays usually comprise highly refined kerosene fractions, while spray or fungicide oils usually employ highly refined oils in the light lubricating oil range.

Union Oil of California, in its U.S. 2,405,775, describes synthetic oils having the insecticidal and fungicidal properties of the natural oils, but also having a more pronounced pleasing odor, low swelling action on rubber, low toxicity to humans, animals, and plants, freedom from sulfur and nitrogen impurities, and sufficient purity and stability to require only moderate finishing treatment with acid, clay, etc.

The invention centers around the use of isoparaffinic products for this purpose, and in particular around the use of heavy alkylate obtained as bottoms from commercial alkylation plants. Oils boiling in the range 350°-800° F. are preferred.

Selected Patents of the Month

U.S. 2,407,997 (Standard Oil Development Co.)—Isoprene separation.

U.S. 2,408,011 (Standard Oil Development Co.)—Adding alkali phenolate.

U.S. 2,408,018 (Standard Oil Development Co.)—Isomerization.

U.S. 2,408,010 (Standard Oil Development Co.)—Electrolytic production of pinacols.

U.S. 2,408,102-3 (Gulf Oil)—Lube containing trivalent salt of a phthalamidic acid.

U.S. 2,408,131 & 146 (Standard Oil Development Co.)—Dehydrogenating hydrocarbons.

U.S. 2,408,139-40 (Shell)—Dehydrogenation to yield diolefins.

U.S. 2,408,164 (Phillips Pet.)—$AlCl_3$-$CaCl_2$ catalyst.

U.S. 2,408,167 (Phillips Pet.)—Alkylation.

U.S. 2,408,173 (Phillips Pet.)—Alkylating aromatics.

U.S. 2,408,186-7 (Texas Co.)—Isomerization and catalyst.

U.S. 2,408,207 (Texaco Development)—Clay treatment.

U.S. 2,408,215 (Texas Co.)—Silica-alumina gel catalyst.

U.S. 2,408,232 (Gulf Oil)—Amine orthophosphate.

U.S. 2,408,265-6 (Glenn L. Martin Co.)—Automatic lubricant.

U.S. 2,408,294 (Phillips Petroleum)—Conversion with $AlCl_3$-$SbCl_3$ catalyst.

U.S. 2,408,297 (Patents & Licensing Corp.)—Adhesive waterproof bituminous composition.

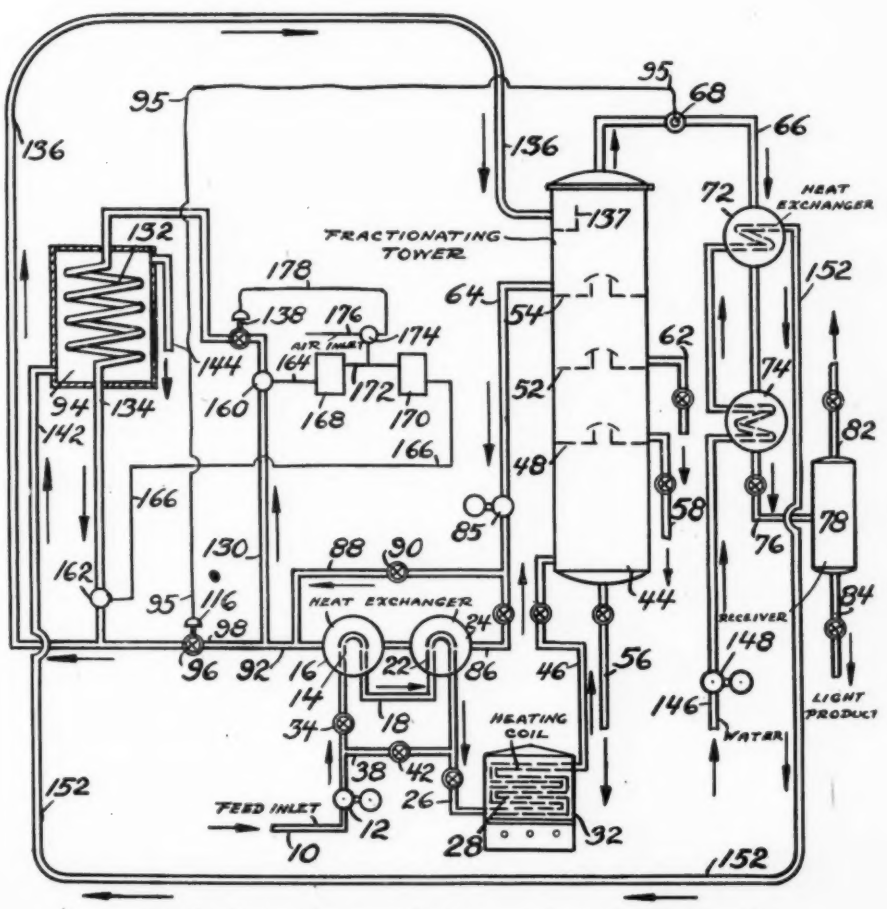

Fig. 2—System for control of temperature of reflux liquid

Flexible Pipe Joint Employs Steam For Packing to Reduce Failures

This month's review of new and improved devices used in petroleum processing and handling operations on which patents have recently been issued includes:

- **Flexible pipe joint uses steam as packing material**
- **Tar filtering method cuts turnaround time by 90%**
- **New heat exchanger designed to reduce corrosion at joints**
- **Safe gaging and sampling device for LPG in tank cars**
- **Time savings possible in repairs on pump crosshead**
- **Prevents vapor lock in gasoline engine fuel line**

A BELLOWS-TYPE, flexible pipe joint which is particularly adapted to carrying supended solids and corrosive liquids, such as are encountered in catalytic processes, has been designed by two Standard Oil Development Co. engineers.

A sketch of the joint in a typical angular misplacement position is shown in Fig. 1. It is pointed out that in the conventional joint of this type, small particles of solids or pools of corrosive liquid tend to lodge in the annular space between the bellows and the liner, resulting in failure of the joint. In some cases this difficulty is overcome by placing a packing material in this space. That method, however, tends to reduce the flexibility of the device.

The present invention claims to remove these two difficulties by introducing steam through Inlet 26 in Fig. 1 under pressure slightly greater than that of the fluid being carried in the joint. In that way, no fluid can enter the annular space, yet the joint permits the full flexibility needed under the extreme conditions met in refinery processing units.

U. S. 2,406,234, issued Aug. 20, 1946, to Joseph V. Marancik and Roy F. Mildrum, assignors to Standard Oil Development Co.

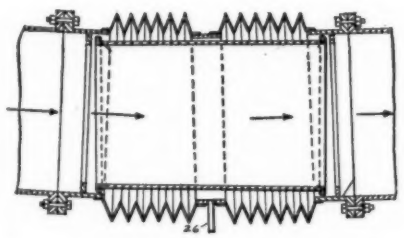

Fig. 1—Bellows-type flexible pipe joint (U. S. 2,406,234) shown in a position of angular displacement. Steam admitted at point 26 prevents fluid in the line from entering the bellows of the joint

Tar Filtering Method Cuts Turnaround Time by 90%

An improvement in the conventional method of filtering cracked tars, in which the average turnaround time is reduced from 26 to about 2 hours, the total cycle time from 85 to about 54 hours, and the capacity factor increased from 62 to about 82%, has been invented by two Standard Oil Development Co. men.

In the conventional method, filtration through a rotary filter using diatomaceous earth is followed by cooling with a low viscosity cracking coal tar, the precoat sprayed with gas oil, and the filter screen scrubbed by hand with steel brushes to remove as much precoat as possible. Because of the formation of gummy, resinous materials during the penetration of the precoat by the tar, this operation has proved costly and lengthy.

With the improved method, filtration is stopped before the last ¾ in. thickness of precoat has been shaved off. Cooling, but no spraying, then follows; and about ½ in. more of precoat is then removed, leaving a ¼ in. thickness of clean filter aid. This is then used as a base for the application of a new precoat of the prescribed thickness (usually about 3 in.), and the entire cycle is repeated.

U. S. 2,404,061, issued July 16, 1946, to Julian P. Hamilton and Charles F. Jones, assignors to Standard Oil Development Co.

How to Obtain Copies Of Patents

Copies of the patents reviewed in these pages are available through the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Payment should accompany all orders; send cash, check, or money order (made payable to the Treasurer of the United States); do not send postage stamps.

New Heat Exchanger Designed To Reduce Corrosion at Joints

Designed primarily as a heat exchanger for acid handling, this invention may find use in the handling of other corrosive liquids because it has been constructed to reduce leaks from joints likely to corrode.

It consists simply of a series of inverted conical shells with spiral grooves as shown in Fig. 2 arranged so that passageways are formed between the grooves for the flow of the fluids. It is claimed that the design of the apparatus is simple and inexpensive, and accommodates a high rate of flow with a minimum amount of metal.

It is claimed that there are fewer possibilities of leaking joints in this equipment as compared with the conventional heat exchanger.

U. S. 2,405,256, issued Aug. 6, 1946, to Delbert E. Jack, and Dale Augsburger, assignors to The Duriron Co., Inc.

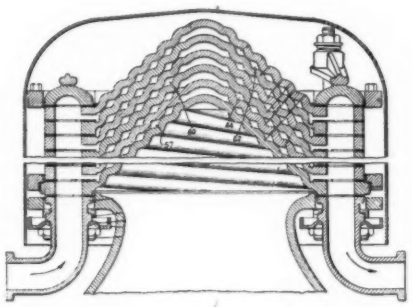

Fig. 2—Cross-sectional view of heat exchanger (U. S. 2,405,256), consisting of a series of inverted, conical, spirally corrugated shells. Patent claims that this design reduces possibility of leaking joints

Safe Gaging and Sampling Device for LPG in Tank Cars

This invention is particularly adapted to gaging and sampling butane or butane-propane mixtures in portable containers such as railroad tank cars, where the liquefied petroleum gases are stored under relatively high pressures.

The device consists essentially of three

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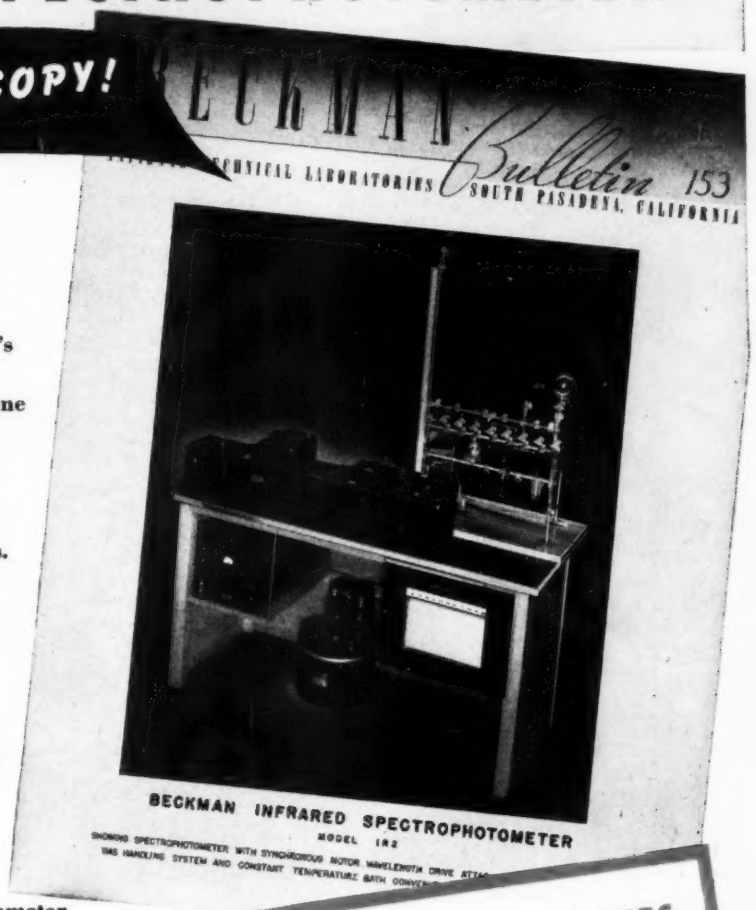


BECKMAN INFRARED SPECTROPHOTOMETER
MODEL IR2

A FEW OF THE IR2 ADVANCEMENTS DESCRIBED AND ILLUSTRATED IN THIS BULLETIN

MAXIMUM VERSATILITY: Illustrations and descriptive matter show how the IR2 handles liquid and solid samples as well as gases . . . how its light sources, cell holders and other elements are interchangeable . . . how these and other features insure maximum adaptability to varying applications.

ELIMINATION OF FALSE ENERGY AND ZERO DRIFT: This important feature is described, and illustrated with typical data and charts.

ELIMINATION OF TEMPERATURE CORRECTION: The method of thermostatting the instrument against temperature variations is described and the importance of this feature explained.

ELIMINATION OF GALVANOMETERS: Beam modulation, energy receiver and electronic amplifier are described, showing how they eliminate the temperature, non-linearity and vibration difficulties associated with galvanometers.

IN ADDITION, internal views of the instrument, light path diagrams, typical recorded curves and many other valuable IR2 features are contained in this Bulletin. It is an invaluable aid to anyone contemplating the purchase of infrared equipment for it gives detailed facts on the latest infrared advancements!

BECKMAN **INSTRUMENTS CONTROL MODERN INDUSTRIES**

valves and a gaging tube contained in a protective cap arranged to prevent loss of liquid even though parts of the device may be injured or destroyed by accident.

For sampling, the cap 21 in Fig. 3 is first removed, valve 38 opened and a sampling container attached. Then the hand wheel 31 is turned. This first opens the valve at B in Fig. 4 (Fig. 4 is the extension inside a tank of the assembly in Fig. 3), and a short interval later, the valve at A in Fig. 3. This consecutive valve opening arrangement reduces the possibility of freeze-up of LPG in the various passages, it is claimed.

For gaging, the cap 21 is removed, all valves opened, and then the entire assembly A is rotated, releasing the gaging tube 10 so that it will freely slide up or down. The tube is moved to the precise point where vapor instead of liquid flows from the valve opening 38. This denotes the liquid level in the tank, and the gage is read directly.

U. S. 2,404,087, issued July 16, 1946, to H. O. Parsons, Houston, Texas.

Prevents Vapor Lock in Gasoline Engine Fuel Line

Vapor lock occurring in gasoline lines between the tank and internal combustion engine causes improper operation of the gasoline pump. A device designed by a Chicago inventor is claimed to prevent this phenomenon.

It is placed in the line just before the pump and filter unit. A cross-sectional view of the device is shown in Fig. 5. It is a small metal cylinder sealed around the gasoline line. A small hole, 28, is provided in the conduit.

Once gasoline starts to flow through the conduit, it also flows into the chamber, 30, through the tiny hole, 28, until the air pressure has been increased to the point where no more liquid will enter. By reason of the phenomenon of partial pressures, gasoline vapor still flows into the chamber; therefore, the troublesome bubbles are readily removed from the line. As this vapor condenses, the liquid gasoline thus formed returns to the conduit through the hole 28.

U. S. 2,403,578, issued July 9, 1946, to Albert F. Carpenter, Chicago, Ill.

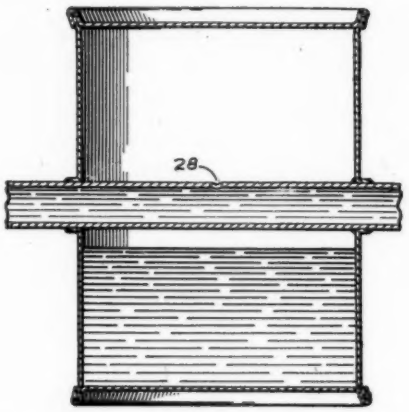
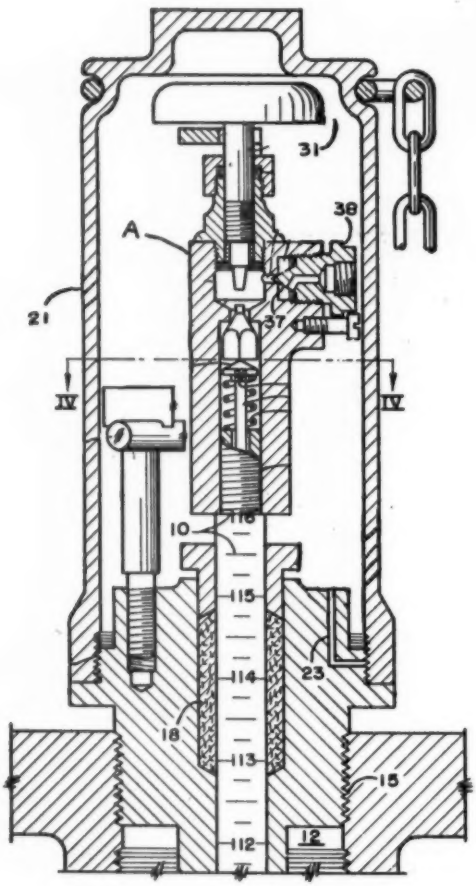


Fig. 5—Cross-sectional view of vapor lock preventive device (U. S. 2,403,578) for use in gasoline lines and the like. Any vapors in the fuel line flow through hole 28 into the air-tight chamber, where they condense back to liquid gasoline



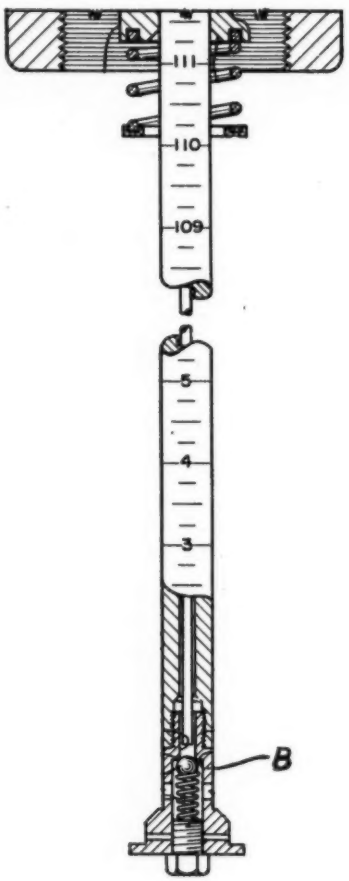


Fig. 3—(Left) Upper or outside section of device (U. S. 2,404,087) for gaging and sampling LPG or similar liquefied petroleum gases

Fig. 4—(Right) Lower section (used inside tank) of LPG gaging and sampling device, top section of which is shown in Fig. 3

Time Savings Possible in Repairs on Pump Crosshead

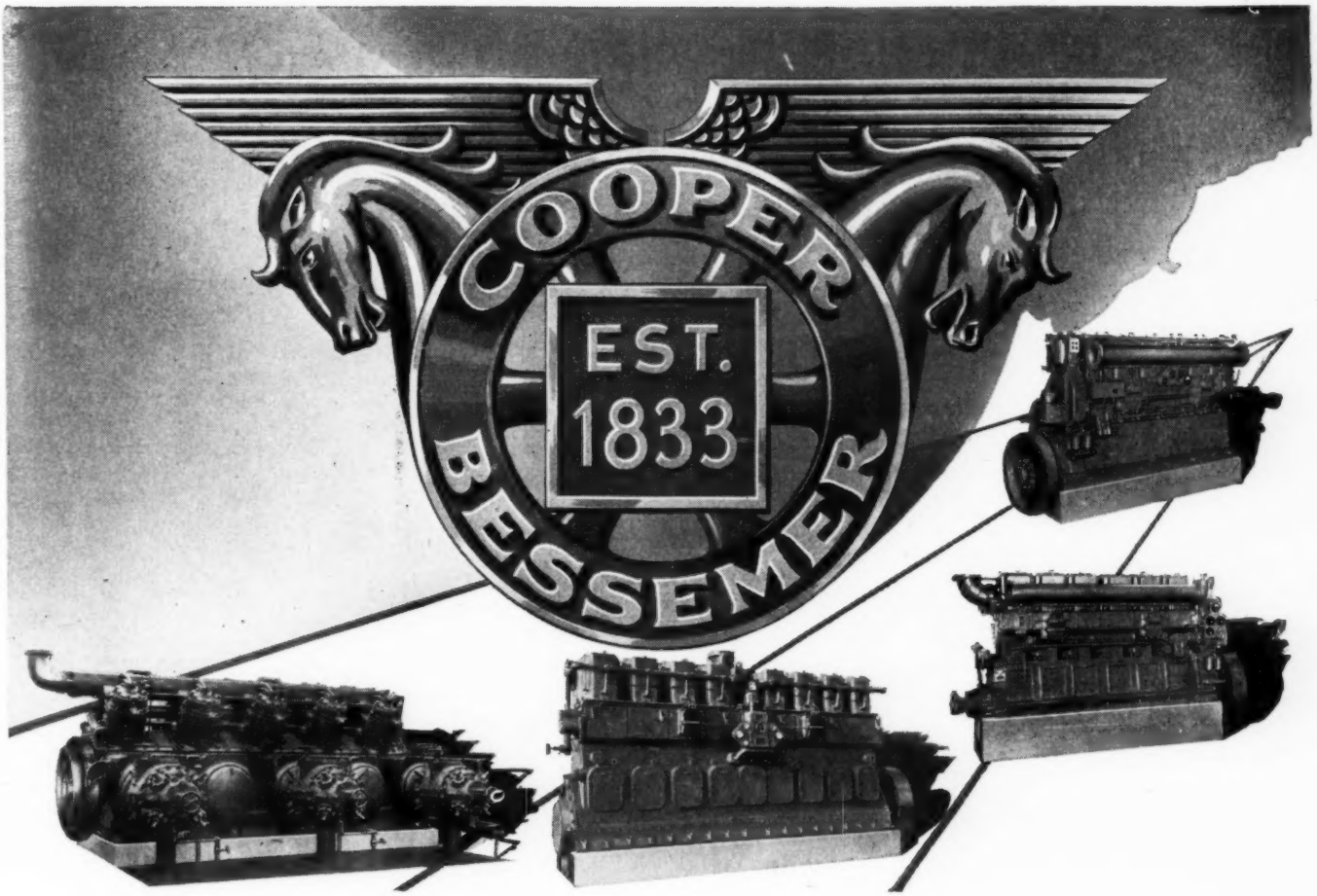
This invention is a reciprocating pump crosshead carrying a plunger in which the plunger is removable without disturbing the alignment of the crosshead bearings or causing the bearing surfaces of the bearing shoe and its slide to touch any surface not touched in normal operation of the pump.

The crosshead assembly is such that it allows removal, in a duplex plunger pump, of the plungers without breaking down the crosshead assembly.

It is claimed that, in present pumps, removal of the plungers for repairs is impossible without disaligning the crosshead assembly or scarring the bearing surfaces. The reassembly of the crosshead in the proper position requires considerable time, even for a skilled millwright, it is pointed out.

As an example of time savings, it was found that with a 3 x 10 in. Worthington duplex plunger pump, five man-hours per plunger were saved, which was more than 65% of the time needed.

U. S. 2,404,835, issued July 30, 1946, to Robert R. Freund, assignor to Phillips Petroleum Co.



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How to Estimate Dollar Savings By Use Of Insulation to Cut Heat Losses

A SIMPLE tabular form for estimating dollar savings in fuel consumption through the insulation of frequently uninsulated hot-fluid piping and vessels has been prepared by the Industrial Mineral Wool Institute. The "Heat Loss Estimate Sheet," as it is called, is shown in part in Fig. 1. Complete instructions on the form (not shown in illustration) reduce the task of the user to counting, measuring, filling in data, and computing the simple formula, which gives a result in potential dollar savings.

The example shown represents the application of the heat loss estimate to a hypothetical power unit and its pipes and fittings. The first column provides for listing of the exposed surfaces. The next five columns permit the accumulation of basic data about the listed surfaces.

After listing the various areas of exposed surface and the basic data concerning them in Columns A to E inclusive, the user is ready for his calculations. The sample basic data shows 100 linear feet of 8-in. diameter pipe with a surface temperature of 324° F. Reference to Kent's *Mechanical Engineering Handbook*, pages 3-64, table 7, shows that under these conditions, one foot of the pipe will lose 1640 BTU/hr. This is listed in Column H, multiplied by 100 for length of pipe, to give 164,000 BTU lost, and listed under Column J. This figure is repeated in Column K on the same line and represents the total bare surface heat loss from piping.

Flanges and fittings are calculated separately, using the basic data in Columns A to E and reference data from Table 5, page 516 in the *Heating, Ventilating, Air-Conditioning Guide*, 1946 Edition. For convenience in calculation, the area of Tees is chosen to represent any fitting and the area of flanges (taken from the same table) is subtracted from the area of Tees of the same size to give the bare surface of the fitting. This is then multiplied by the number of fittings to give a figure which, in this case, is about 33 sq. ft. To this is added the area of flanges from the same sources; in this case about 24 sq. ft., to give a total of 57 sq. ft. in Column F. By referring to a surface temperature-heat loss graph printed on the reverse side of the estimate sheet a rate of 685 BTU/hr./sq. ft. is found.

Multiplication of data in Columns F and G gives a total surface loss of 39,045 BTU/hr. for these fittings and flanges. This again is recorded in Column K.

The same process is carried out with respect to the drum heads to give a total loss of 79,800 BTU/hr. This combines with the other data in Column K to give a grand total of more than 280,000 BTU/hr. loss.

Tables 1 and 2 in the heat loss estimate sheet give recommended sizes of mineral wool insulation for the protection of equipment of various sizes at varying temperatures. With this figure selected, it is necessary only to refer to the graph showing heat losses with insulation and multiply by the linear pipe or square feet of fittings (Columns B and F) to get the figures in Column M. These are subtracted from corresponding figures in Column K to give Column N, showing the savings in heat loss to be had by the application of mineral wool insulation to bare surfaces.

Another simple formula converts these figures into dollars of savings for coal, oil, or gas. Experience shows that the average savings run in excess of 87% and that the cost of insulation is defrayed through savings in periods of time varying from less than one month to as much as 15 months depending upon the nature of the exposure and the type of fuel used.

TABLE 1—Recommended Thicknesses of Insulation for Pipe Covering

Steam Pressure or Condition	Temperature, °F.	Thickness of Insulation for Pipes—5 in.	4 to 4½ in.	2 to 3½ in.
Hot Water		1	1	1
0 to 25 lbs.	212 to 267	1	1	1
25 to 100 lbs.	267 to 338	1	1	1
100 to 200 lbs.	338 to 388	1½	1	1
Low Superheat	388 to 500	1½	1½	1
Superheat	500 to 600	2	1½	1½
High Superheat and Hot Oil Lines	600 to 700	2	2	1½
	700 to 800	2½	2	2
	800 to 1000	3	2½	2

NOTES: For outdoor piping increase thickness ½ in.
For underground piping decrease thickness ½ in.

TABLE 2—Recommended Thickness of Insulation for Flat Surfaces

Operating Temperature, °F.	Thickness, in.
100 to 200	1
201 to 300	1½
301 to 500	2
501 to 700	2½
701 to 900	3
901 to 1100	3½
1101 to 1200	4

Fig. 1—Tabular form for estimating dollar savings through use of proper insulation. Figures are from example given in accompanying article

Copyright 1943 by Industrial Mineral Wool Institute
441 Lexington Ave., New York, N. Y.

HEAT LOSS ESTIMATE SHEET

Company _____
Plant _____
By _____
Date _____

DESCRIPTION	SURVEY DATA A: Size	B: Pipe (Lin. Ft.)	C: Pipe Fittings (Number)	D: Flanges (Number)	E: Surface Temp. (°F.)	CALCULATED DATA F: Flat Surfaces Fittings & Flanges (Tot. Area—Sq. Ft.)	G: Bare Flat Surface Loss Rate (BTU/hr./Sq. Ft.)	H: Pipe Surface Loss Rate (BTU/hr./Lin. Ft.)	I: Tot. Bare Flat Surface Loss (BTU/hr.)	J: Tot. Pipe Surface Loss (BTU/hr.)	K: Tot. Bare Surface Loss (BTU/hr.)	L: Thickness of Mineral Wool Insulation, Pipe	L: Thickness of Mineral Wool Insulation, Flat	M: Est'd. Tot. BTU Insulated Loss (BTU/hr.)	N: B.M.—Tot. Savings (BTU/hr.)	O: Conversion to $ Savings
Piping	8" Dia.	100			324			1640		164,000	164,000	1½"		21,900	142,100	$399
Flanges & Fittings for:	8" Dia. piping		10	10	324	57	685		39,045		39,045		2"	3,306	35,739	100
4 Drum Heads	5'0" Dia.				350	100	798		79,800		79,800		2"	6,400	73,400	206
											282,845				251,239	$705

Designing Disposal System for Discharge Of Uncontaminated Waste Waters

Article 11 in a Series

By W. B. HART

In Charge of Waste Disposal for Atlantic Refining Co.

Disposal of uncontaminated wastes from refineries and natural gasoline plants by reuse, as for cooling purposes, is an economic advantage to plants in many instances. Where disposal must be made to nearby surface waters, care must be taken to avoid damage to waters from the so-called uncontaminated wastes. There should be provision for rapid admixture of waste with the surface water. Equipment for disposal into various types of surface waters is described and illustrated.

THE ideal way of solving the problem of industrial waste disposal is not to produce the waste. This is not possible always, but the uncontaminated waste can be reused and need not become waste water in the sense that it must be disposed of by discharge from the refinery into adjacent surface waters. This is fortunate under some circumstances, particularly in regions where water is not plentiful.

In regions where large supplies of surface water are not to be had, refineries usually depend upon wells for their cooling water supply. Some plants are located where the only signs of a waterway in the vicinity are dry stream beds which carry water only at times. Plants so located, and depending upon wells, must conserve all water they can. As a part of this procedure uncontaminated waste cooling water is circulated over cooling towers and reused.

Disposal by reuse can be applied in any refinery, and it offers several advantages. Where a single sewer system is used, and a single final waste treatment plant serves to correct the entire waste for discharge, reuse of uncontaminated waste will remove a great part of the load on the treatment plant, or permit use of smaller size equipment.

Cooling Water Must Be Oil Free

Cooling equipment, however, must be accorded protection, and the water to be reused must not carry oil. It is necessary, therefore, to maintain this freedom from oil at the still coolers and so forth, just as if the water were to be discharged to some lake or stream. Cooling tower basins, or cooling pond reservoirs, must be cleaned from time to time. The accumulated mud and slime must be disposed of in a manner which will not permit washing to surface waters, for usually no treatment plant will be provided specifically for such infrequently occurring wastes.

When disposal must be made to some body of surface water, and particularly when the waste water has been cooled and aerated (to increase the dissolved oxygen), there should be provision for quick admixture with the surface water. There is little reason for cooling and aeration or for a treatment to provide a satisfactory concentration, unless that concentration is attained by rapid admixture with the receiving water. The attainment of this complete admixture obviously will vary with local conditions, i.e., whether the receiving water is a stream or a lake, and the type of either. There also must be considered any local regulations, and precautions to safeguard navigation or to protect the disposal equipment. These matters, as well as disposal equipment design, can be discussed only in general.

Disposal Into Various Streams

Disposal sometimes takes place into a small stream subject to the usual seasonal flow variations. The degree of treatment will be determined by the amount of water at base flow. Assume a relatively small, rapid stream where navigation is not a question. Then the full width of the stream may be used unless the discharge is of a nature which makes a bypass or a fish-way desirable.

With conditions as above, the outfall sewer may be extended along the bottom of, and as far across, the stream as desired. It should be perforated at intervals, or in some other way designed to discharge the waste water along its entire submerged length. In such a stream there usually will be sufficient turbulence to bring about rapid and complete mixing. The necessity for assisting this mixing action in slower moving streams can be met by applying one of the laws of fluid mechanics which concerns flow past 90° angles.

A barrier in the form of a submerged weir is provided immediately down stream from the discharge pipe and is turned in to meet the end of the pipe. Such a barrier can be constructed of lumber and held in place by stakes, driven into the stream bed, to which the barrier can be bolted. If stakes cannot be securely driven into the stream bed, the barrier can be fastened to straps around the discharge pipe. A barrier constructed of a good grade lumber will last a long time.

Such a disposal system will require little attention other than inspection from time to time. Occasionally it may be necessary to flush out accumulated silt. It usually will be unnecessary to anchor the line, for being open to stream flow, and therefore filled with water, it will not float. It should be submerged so that it will not be damaged by floating debris or surface freezing, and protected on the upstream side against bottom rolling debris. In cold climates special protection against heavy ice may be necessary. Disposal systems of this design are shown in Figs. 1 and 2.

For deeper, slower moving streams, which afford greater flow for admixture with the waste water, the same design as above may be applied but the disposal line need extend out along the bottom only part way. Larger streams of this type may be navigable, and under the supervision of the Army Engineer or some State agency. Then it may be necessary to obtain a permit before the disposal line can be installed. It will save difficulty if Army Engineer or State agency regulations are investigated in every case.

Extra Caution in Large Streams

When disposal is planned for large streams, which usually are sluggish near the shores with a more or less central channel, a different arrangement is sometimes used. This consists of a line without distribution openings near the shore, but with such openings provided in the regions approaching the channel where there is the greatest natural turbulence. The line should extend along, or may be buried in, the bottom and then turned upward into a side branched cross so

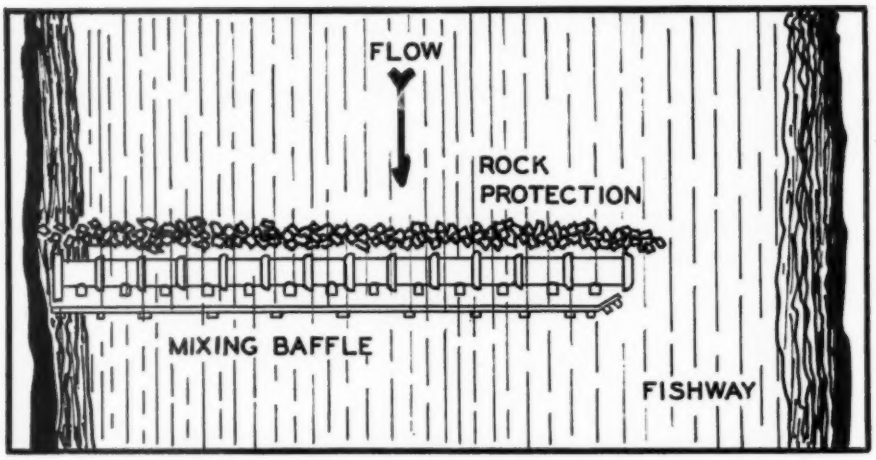

Fig. 1—Plan view of disposal system for a small rapid flowing stream. Discharge pipe rests on stream bottom, protected by rock dike immediately upstream. Turbulent mixing action is produced by submerged wooden baffle in front of discharge nozzles. Pipe may extend completely across stream unless a free-flowing fishway is desired

the waste will be discharged horizontally in four directions. The cross must be located at a depth which will not interfere with any movements of surface craft, and the line should be located, whenever possible, in such a way that interference with any other use of the stream will be at a minimum. It is not advisable to extend the line into the channel, or into any portion of the stream where dredging may occur, for it may be damaged or may have to be moved.

The idea behind this construction is concerned largely with aquatic life. The aquatic life of large streams is found largely in the shallower waters nearer the shore. Even the largest fish come into these waters to feed because this region is the habitat of most food forms. It also is the region in which fish spawn. So if the line is not open at any point as it passes through the shallow shore waters, these waters and all aquatic life in them will be protected. Any properly treated waste water introduced as recommended will be thoroughly mixed before any stream current carries it near the shore. The arrangement is illustrated in Fig. 3.

Problem of Tidal Regions

Proper disposal of waste water into tidal regions of streams presents problems peculiar to the tidal action. Normal stream flow results in a reasonably constant quantity of water passing the point of discharge each minute of any day, the lowest flow rate being the base flow of the stream. This is not true in tidal regions, where at times of rising tide the rate of flow is reduced by the incoming tide. The quantity of water at flood tide into which the discharge passes may be as great, or even greater, than the normal flow of the stream at any given instant, but this quantity of water is more or less in a pool stage.

Consequently, a knowledge of the conditions of flow at both high and low tides at the point of discharge is necessary. Then the rate of discharge, or the degree of treatment, can be so adjusted that planned concentrations will result in the stream. Or, if there is reservoir capacity for the waste, the rate of discharge may be retarded during pool stages and increased when rapid flows occur.

Temperatures at various depths may cause a variety of current conditions, and it may be that no well defined pool-stage will be found. This can be regarded as fortunate, and it should be established clearly. A procedure by which currents can be identified involves the use of floats such as those shown in Fig. 4. These floats can be set to show currents at various depths. A float survey of the tidal surface waters should cover a sufficient number of days to assure all reasonably frequent variations. Meeting this condition may require surveys at different seasons of the year. When the current rates have been approximated, and the currents reasonably well defined, the design for new equipment or for the modification of existing equipment can be prepared with confidence. Also, it may be established that

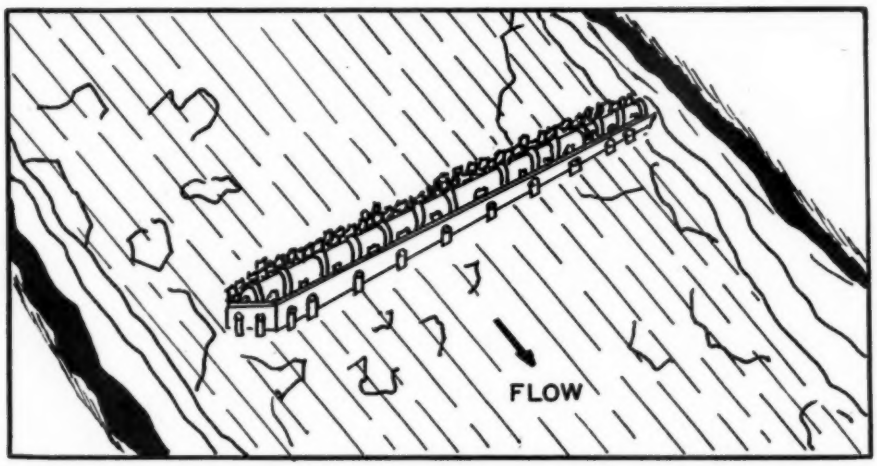

Fig. 2—Isometric sketch of the disposal system for a shallow rapid stream shown in Fig. 1

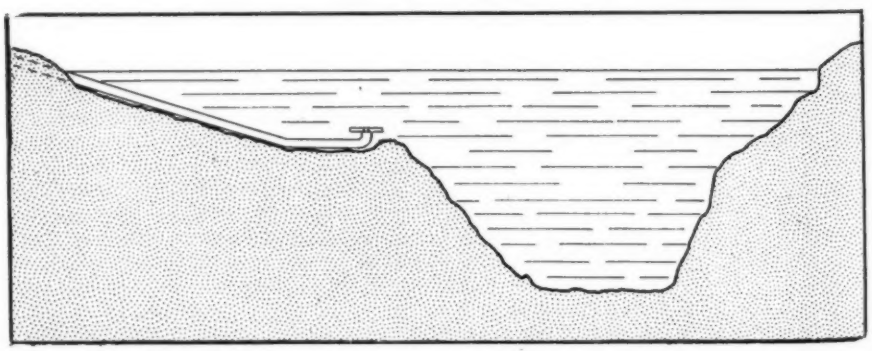

Fig. 3—In large, navigable streams, waste is conducted in a pipe resting on stream bottom or buried just below the surface to a cross head. Cross head is kept out of deep, navigable portion of the stream, and provides necessary mixing action for the discharge

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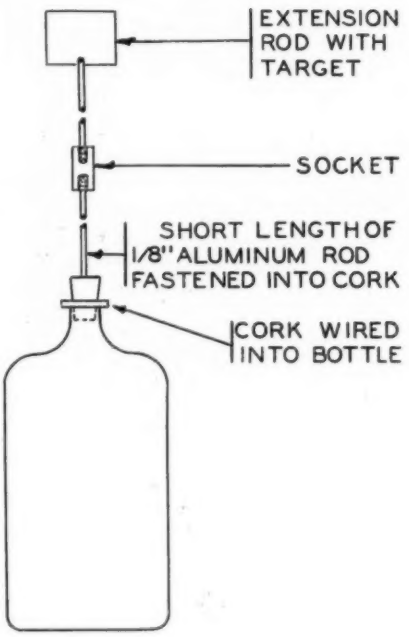


Fig. 4—Quart bottle used as a float in the measurement of stream flow rates. The bottle can be weighted with sand so as to float at various desired depths. Extension rod sections can be added as needed

a less drastic treatment of the waste will be possible.

Problem of Lake Discharge

The problem of tidal regions may be looked upon as a transition problem lying between disposal into streams and into lakes. Disposal into lake waters has often caused discussion on the subject of dilution. The question raised concerns the legality of using surface waters as a diluent for waste waters. This question is related to the type of law which says that no waste shall be discharged which is harmful to aquatic life, and so forth.

The only logical interpretation is that concentration of waste is the important factor. Otherwise, not a single drop of waste could be discharged, for if substance regardless of concentration were the primary consideration, neither water itself, nor any of the compounds naturally present in surface waters could be discharged. Any of these substances are present in waste waters, and any of them, in sufficient concentration, will be lethal if for no other reason than osmotic effects. This can be true even in sea water. Therefore, the quantity of water available to dilute any waste is important and must be known, and the waste must be treated to such an extent that its most harmful or obnoxious component will not reach a harmful or objectionable concentration when discharged into that quantity of surface water. The problem of quantity, specificially lake currents, is the problem of disposal into lake water.

Lake currents are variable, and the variations are traceable to a variety of reasons. They have been discussed by Welch[47] and others[49, 139.] But each lake is individual, and surveys may be necessary for thorough information as to its currents and general conditions. Here again, as in the tidal regions of streams, floats can be used. A study of temperatures at different depths also will prove to be profitable in connection with the current studies. Various scientific societies[140] may make available useful information on local lake currents and conditions. It may be possible to have some organization conduct the studies for a consideration. This procedure would provide a variety of reliable information which would be very useful. Facilities for lake disposal will be the same fundamentally, as for disposal in streams. They will be modified as required for the specific disposal point so as to produce rapid admixture and removal.

There is one important matter of design in every disposal system. It concerns the inlet end of the disposal system, or the line leading to it. This inlet never should be so designed that air will be drawn into the flow and carried along in small bubbles. This often results when the inlet end is not completely submerged, or when it is alternately partly open and closed in a sort of pulsating flow. Although actually this is a helpful feature, in that it contributes to the dissolved oxygen, it has the effect of bringing about accusations by individuals who are not too careful of their statements that pollution is occurring. This is because the air, rising to the water surface, may give the appearance of a grayish or white film which under some circumstances may be irridescent.

Handling Storm Run-off Waters

One of the most frequently discussed subjects of refinery waste treatment and disposal is storm run-off water. Usable procedures for estimating the quantity of run-off and for holding the quantity of contaminated run-off to a minimum, will be the subject of the next article in this series. Consideration will also be given to treatment and disposal of run-off.

References

(139) "Progress in biological inquiries." *U. S. Bur. Fish.* Appendices to the Report of the Commissioner of Fisheries. (Annual issues containing resumes of limnological work on the Great Lakes, inland lakes and rivers).

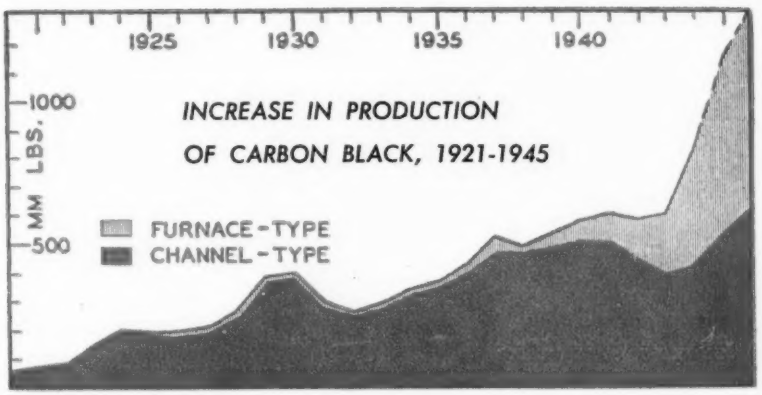
(140) Limnological Society of America. Paul S. Welch, President, Univ. of Michigan, Ann Arbor, Michigan. G. L. Clarke, Secretary-Treasurer, Biological Laboratories, Harvard University, Cambridge, Massachusetts.

CARBON BLACK MANUFACTURE

High Utility Value Dependent Upon Low-Cost Natural Gas

By JOHN F. GALLIE

Geologist, The Cabot Companies



The manufacture of carbon black, especially by the newer furnace methods, has climbed steeply during the war years to all-time highs as shown in the graph above.

Channel, thermal, and various furnace methods of carbon black production are described and analyzed with respect to both quantity and quality of yields. Although the homologous methane series takes first rank as a raw material, methods have been devised for using olefins, diolefins, acetylene and anthracene. In his concluding section, the author discusses the economics of using natural gas as a raw material for carbon black manufacture, and takes issue with the view that it is more important to make higher priced products (e.g. plastics and synthetic rubber) from natural gas than it is to make cheaper products (e.g. carbon black).

THE carbon black industry, which plays an integral and indispensible role in rubber compounding, has just completed its greatest expansion in the 75 years of its existence. When it is recognized that 40 pounds of black are used for every 100 pounds of synthetic rubber—moreover, that the 100 pounds of rubber are virtually useless without it—the reason for this expansion is evident.

In 1941, total production of carbon black was set at a peak of nearly 600 million pounds, of which one sixth was furnace-type black. By the end of 1945, the production of furnace-type black alone was scheduled to exceed this prewar total. However, cutbacks since the war's end may have prevented attainment of this goal. Expansion was also taking place in channel-type carbon black plants, the full effects of which are not yet evident.

In a little more than a week after the Baruch Rubber Report was made public at the start of the war, Thomas D. Cabot had filed with the War Production Board the first of a number of industry analyses of wartime carbon black needs. He estimated that total channel black plant capacity was then 550 million pounds annually. However, many units then stood idle because of inadequate gas supplies, this factor alone decreasinging productive capacity to approximately 425 million pounds.

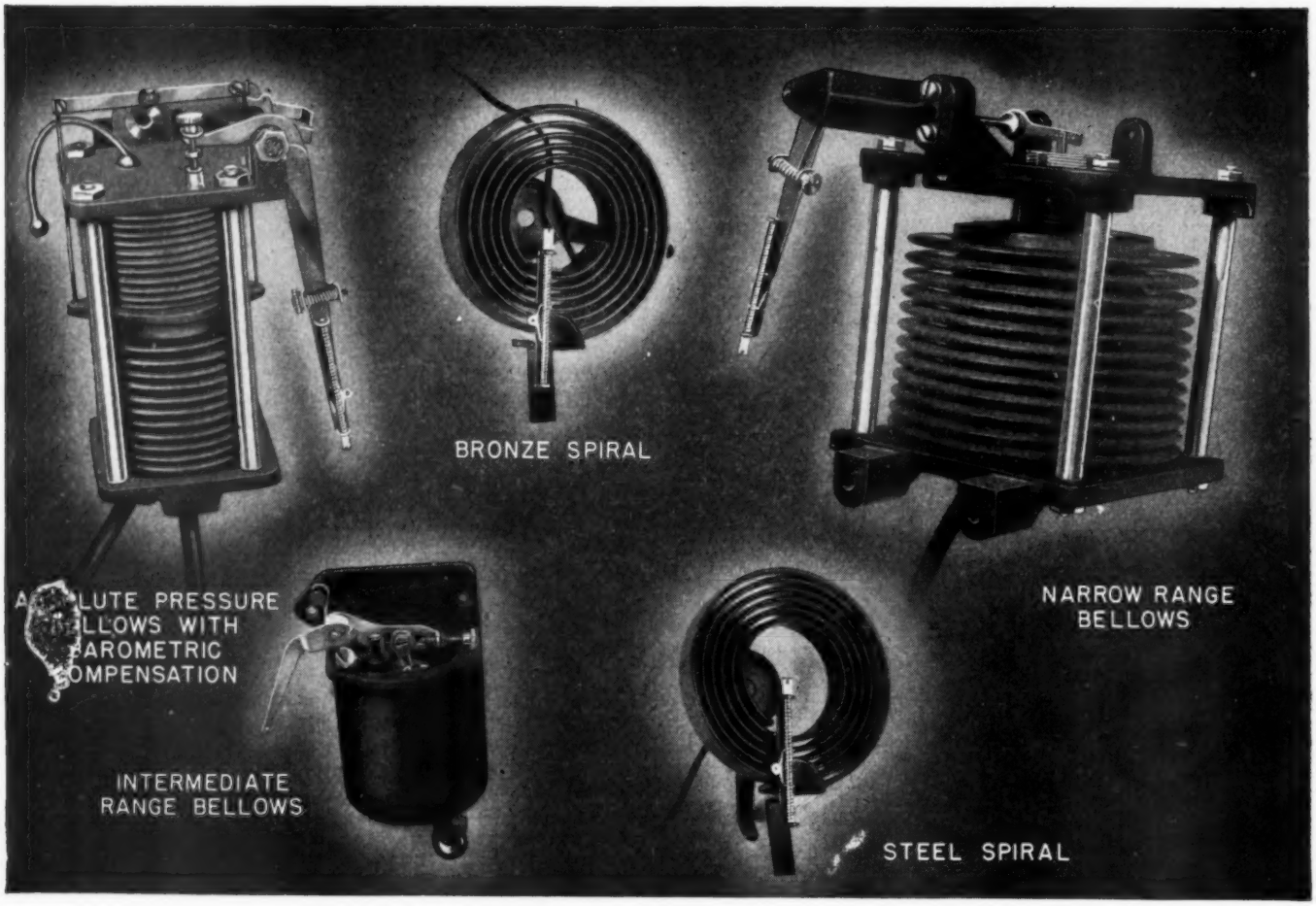
Further, a change from the production of optimum yield blacks, particularly to the soft, easy-processing black for which demands were steadily increasing, would reduce individual plant productivity an additional 10-50%, depending upon the richness of the available gas. Statistics covering 1942 and 1943 closely corroborated this earlier estimate of industry ability. Channel black production equalled 429 million pounds in the first war year and 380 million, or 11% less, in the second, attendant upon the increased demand for easy-processing black.

Steps had even earlier been taken by the industry to increase production of furnace blacks, whose easy processing and low heat build-up properties offset converse properties of the elastomers. The high loading ability of these blacks also was fundamental to the conservation of limited natural and synthetic rubber stocks. The industry was largely immobilized, however, insofar as additional production of channel black was concerned, by the dual considerations of steel and gas. Channel black plants took eight times as much steel and five times as much gas as furnace-type plants for the production of an equivalent quantity, if not quality, of black. In the critical period for steel and when increased demands were being made for natural gas, furnace plants appeared to many to be justified in place of channel plants, which required 300 tons of steel and upward of 714 million cubic feet of gas per million pounds of annual production of carbon black.

The result, early in 1945, was a temporary but none the less alarming shortage of black which necessitated cuts of 5-25% in its use. This was due not alone to the lag in construction of channel plants, but also to the unwillingness of some producers to sell even waste gas at a price the industry could afford to pay for incremental production from idle units. A spokesman for one producer, it was divulged in the Congressional investigation of the shortage, flatly stated that his company would flare its gas rather than sell it for carbon black at the prevailing low rate.

To alleviate the shortage in 1945, labor and material priorities were granted on all pending channel black projects. In addition, the PAW, which had earlier aided the industry in securing additional gas, diverted over 18,000 bbls. daily of liquid hydrocarbon feed stock to furnace black products to plants for purposes of gas enrichment. This production had to be subsidized, the base stock alone exceeding the value of the finished product. At a cost of 2½-5c per delivered gallon of propane, a pound of black selling for 3.3c cost 10-20c to produce.

Despite the industry's almost complete dependence upon distress gas—too sour, too low pressure, or too remotely located to permit its use in pipe lines—the performance of its wartime task was made doubly difficult by a resurgence of ill-founded "inferior end use" reasoning. This was touched off by those



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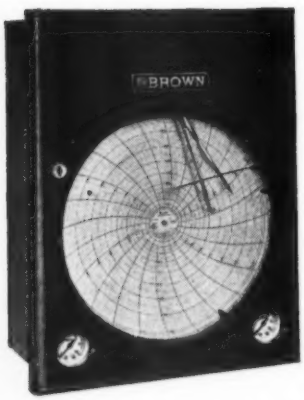

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who heralded the new gas-chemical technology as the savior, for "superior" use, of the nation's gas. In this connection it need only be noted that the recent report on natural gas utilization in Texas which was issued by Governor Coke Stevenson's fact-finding committee has, through sheer weight of facts and figures, given added emphasis to the uncommon good sense expressed by E. De Golyer at the June, 1945, meeting of the Interstate Oil Compact Commission. "First things first," Mr. De Golyer stated. "Let's don't worry about end use as long as we burn a billion feet a day in flares."

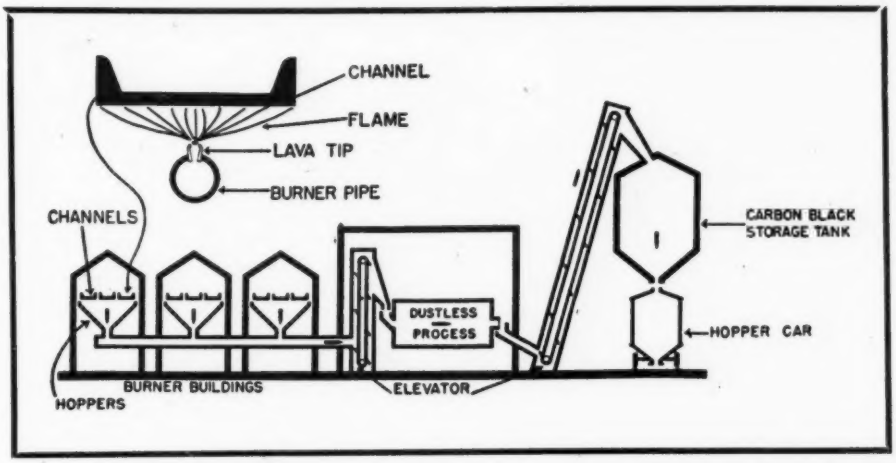

Fig. 2—Simplified flow diagram of channel process for carbon black manufacture (contact method)

Channel Black Manufacture

Much has been written about the impingement method of manufacture of carbon black, and only brief review is given here of the principles involved.

The tiny flame illustrated in Fig. 1-A is the simple production unit within the confines of which the carbon black manufacturer must create the blacks of widely varying properties demanded by compounders of rubber, ink, paint, and a variety of other products. This small flame provides furnace and fuel alike. The outer sheath of gas, in burning completely admixed with air both constitutes the furnace walls and raises the temperature sufficiently to decompose hydrocarbons within the inner airless zone. The impingement surface prevents complete combustion of the gas, the liberated carbon clinging on until scraped off the smooth channels just above the hoppers. From the hoppers the black is fed by conveyors to the packing house.

Of more than a hundred types of lava tips which have been used in the development of the industry, the bat-wing type shown in Fig. 1-B has been largely standardized upon. Small round flames still find use in the roller process of manufacture, production from which is limited; but, with perhaps this exception, manufacturers have been able to modify other conditions controlling production to permit almost universal use of the fan-shaped flame shown in Fig. 1-C.

The advisability of using such a flat flame has been demonstrated experimentally in extensive research with both flat and round flames wherein the factors of gas flow and channel height were varied with respect to one another. The flat flame tends to diffuse over its broader surface of contact the effects of those variables which control individual flames in the hot house. The round flame, by virtue of its shape, concentrates all such effects within the limited contact area afforded. Fig 2 shows the complete channel process for manufacture of carbon black

Thermal Manufacture

The thermal and furnace methods of manufacture have been utilized to better the yield of black obtained per unit of gas utilized.

A thermal process was patented as early as 1913 by Gustav Fernekes, but this was not used commercially. Several years later, however, Brownlee and Uhlinger secured a basic patent on a process for the decomposition of natural gas in a refractory chamber, the end products obtained being hydrogen and a coarse, grayish thermal black, the latter possessing qualities quite distinct from those of the 27 or more times finer contact blacks made by the impingement process.

The thermal process (schematic diagram in Fig. 3), unlike the channel and furnace processes, is cyclic in nature, involving gas preheating of a large checker-work furnace to a temperature upwards of 2400° and batch cracking of gas subsequently passed through the hot firebrick. Following passage downward through the furnace, the residue gases carrying such carbon as is not inescapably trapped on the face of the refractory firebrick are cooled by passage through a water spray, whence the black is led into a bag filter for collection. Such carbon as is not carried from the furnace by the exhaust gases (principally hydrogen) is burned in the process of reheating the furnace prior to the admittance of additional cracking gas.

In 1942 Shell Chemical Co. entered the thermal black field, theretofore dominated by the Thermatomic Carbon Co., when the Pyzel process for the cracking of refining waste gases to hydrogen and carbon black was placed in operation at Shell Point, Calif. Here the

Fig. 1—Burner unit for the production of carbon black. Fig. 1-A (left), schematic diagram of flame, darkened area indicating the zone in which black is formed; Fig. 1-B (center), standard bat-wing type of burner tips; Fig. 1-C (right), type of flame produced by the bat-wing tip

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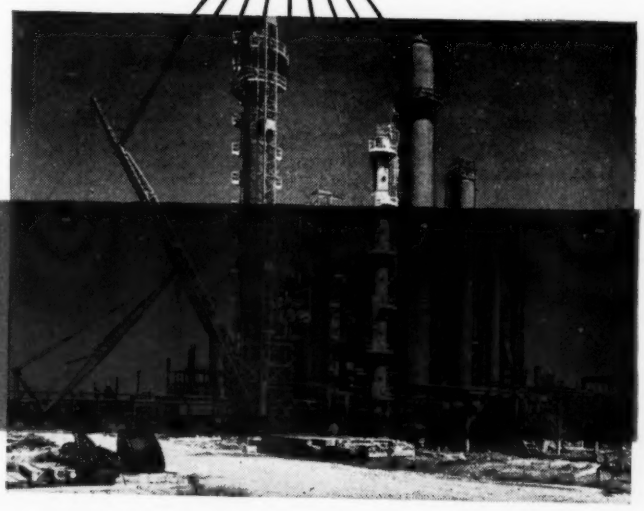

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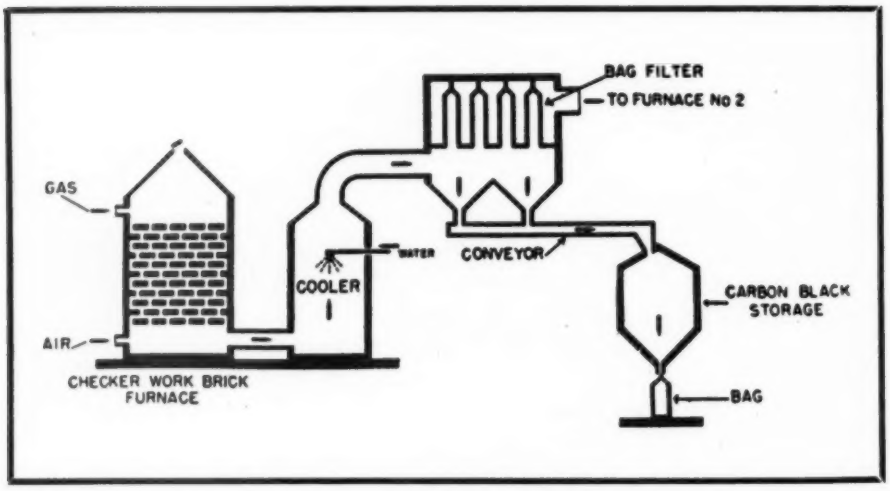

Fig. 3—Schematic diagram of thermal decomposition process for carbon black manufacture

production of hydrogen for ammonia synthesis was the primary aim, justifying the production of an inferior black possessing limited utility. The Pyzel process is not unlike the Thermax process employed by the earlier concern, basic differences lying in a reversal of the flow pattern for heating and cracking gases, and in the collection system. Following passage of the exhaust gases bearing carbon upward through the checkerbrick arrangement, they are sprayed by water, after which the black is collected in a wash box for subsequent filtering, drying, pulverising, and screening.

The fundamental objection to thermal black was its coarse, grayish nature, which rendered it unfit for most uses. This objection was overcome to an appreciable extent in experimentation by the Thermatomic Carbon Co. which resulted in the development of a finer thermal black through use of a diluent gas.

In the production of this black, with properites intermediate to those of channel and coarse thermal black but appreciably nearer the latter, the residue gases were reintroduced in a volume reportedly approximating 2:1. The resultant black, finer in particle size and darker in color, has found more widespread use in rubber because of its higher tensile, tear, and elongation properties which, coupled with low modulus, permitted higher loadings. Its value in this respect has been strengthened during wartime when higher loadings, up to 50% of the rubber by volume, have served to lengthen the rubber stocks on hand to an amazing degree.

Furnace Combustion Process

In 1928 two furnace combustion methods of production were initiated, the Matlock process being the first patented (1922). This process was seemingly patterned after methods used in the production of lampblack, large flames being burned in a vertical furnace inadequately supplied with air. As in the channel process, the process is continuous, with gas simultaneously furnishing fuel and raw material. This black proved to be intermediate to the coarse thermal and channel blacks, and although not far removed from fine thermal black in the carbon black spectrum, possessed certain outstanding differences, notably in reinforcement properties. This black became known as Fumonex or Furnex black.

The second furnace process to be initiated was the result of experiments carried out by a group of engineers under conservation-minded Henry L. Doherty. The first plant to be built under patents issued to the group was near Pampa, Tex. The Gastex process, developed over a period of years, made use of special furnaces in which alternate layers of gas and air, the latter predominant, were introduced through a vertical bank of special wide-mouthed burners. Excess air introduced at the top prevented accumulation and agglomeration of carbon particles on the roof of the furnace employed. Fig. 4 provides a close-up view of this type of burner, and Fig. 5 shows a view of a complete Gastex unit.

For the collection of black, both Furnex and Gastex processes originally made use of a bag filter system such as that utilized in the separation of Thermax from residue gases. General Atlas, the producer of Gastex, subsequently experimented with and adapted the Cottrell electric precipitator for collection. By means of this device, carbon particles, negatively charged by introduction to an electrical field, are agglomerated on collecting electrodes, whence some drop to the bottom of the hopper and still others, pulled off by the residue gases passing through the Cottrell system, are carried into the first of the two cyclone separators. In the course of the ensuing treatment they regain their identities as individual particles.

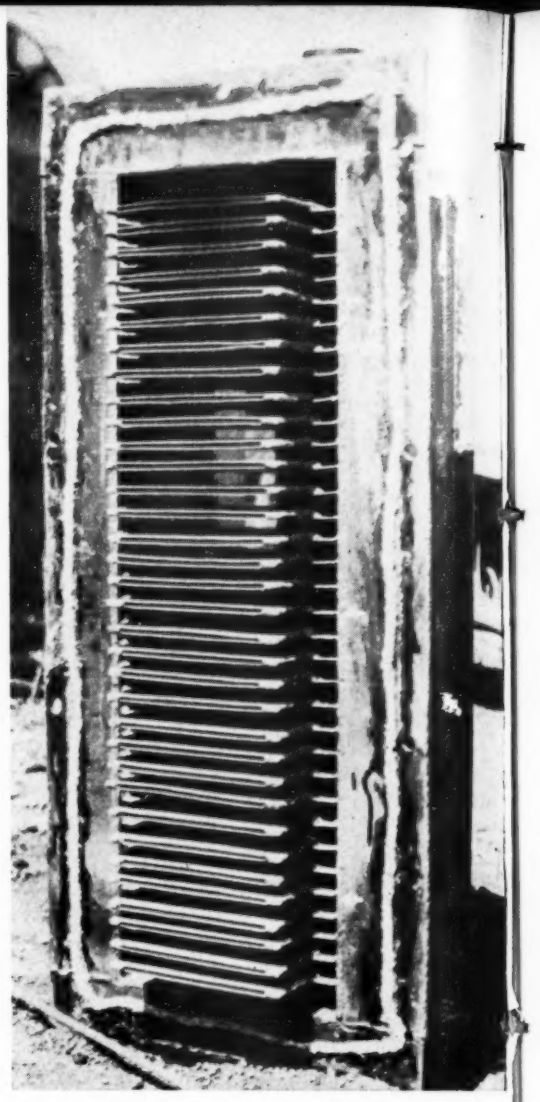

Fig. 4—Close-up view of burner unit for Gastex or General Atlas furnace-type process, in which alternate layers of air and gas are introduced through the vertical bank of wide-mouthed burners

The plant shown schematically in Fig. 6 makes use of this system of collection, which has since also become standard with the Furnex system. A close-up of this type of collection system is shown in Fig. 7.

Rubber Industry Spurs Major Producers

Attendant upon the increased demand for furnace blacks for use in synthetic rubber and more particularly in the very large part of rubber stocks entering into the manufacture of large-diameter, heavy-duty truck and bus tires, all major producers of carbon black have entered the furnace black field. One of these has used oil in conjunction with gas to obtain a high modulus furnace black with properties intermediate to those of furnace and contact blacks. A newcomer specializing in this field has been the Phillips Petroleum Co., producers of Philblack, derived through the use of preheated degraded oil and a re-

portedly subordinate quantity of gas. No reliable data are available on the production of this black, but a flow diagram would supposedly not differ greatly from the generalized sketch provided for the furnace system.

All Blacks Not Equivalent Products

The point which must be stressed in any general consideration of furnace and thermal blacks vs. contact or channel blacks is that they are not equivalent products, but occupy altogether different positions in the carbon spectrum. Each type has found distinctive uses, while continued experimentation has also developed exceptional uses for blacks in combination.

The coarser furnace and thermal blacks may be produced in yields up to 16 lbs. per MCF as against a maximum slightly in excess of 2 lbs. for contact blacks. Yet has contact black particle size, which governs surface area and is thereby seemingly intimately related to reinforcement properties, is approached with furnace black production methods, the yield of the latter drops sharply. High modulus furnace black, for instance, is obtained in about half the yeild for semi-reinforcing furnace black, fine furnace in approximately a third, and conductive furnace somewhat less.

When contact black emerges from the flame it is 97% air and bulks only 3 lbs. per cu. ft. Practices were adopted to compress the black within bags to as much as 25 lbs. per cu. ft. for commercial usage. A serious drawback, however, was that it made the black more difficult to disperse in processing. Experimentation resulted in the development of wet and dry processes for pelletizing black. The pellets so formed bulked the same or slightly less than heavy-compressed blacks and the individual carbon particles were more easily dispersed. Fig. 8 compares a heavy compressed carbon black with Cabot Spheron, a dry process pelletized black.

Economics

The various methods of manufacture of carbon black heretofore considered have made common use of natural gas, at least in part, as fuel and raw material. While combustion and decomposition of the homologous methane series takes first rank in production, methods have been devised for the manufacture of blacks from olefins, diolefins, acetylene, anthracene, etc. Blacks secured from these sources lack the diversity of characteristics of blacks manufactured from methane.

Prior to the wartime development in the U. S. by Cabot of a method for the production from natural gas of black having high absorptive power and low resistance, Canada supplied the bulk of the black required for use in dry cells. This premium-priced black could be derived from acetylene through processes closely related to the channel and thermal methods of manufacture or through decomposition by electrical sparking under a pressure of two atmospheres. Small quantities were also obtained as a by-product in the electric arc production of acetylene from methane.

The Germans reportedly began their attempts to develop substitute blacks as early as 1922, when world-wide attention was focused upon the outstanding properties conveyed to rubber through compounding with carbon black. The unsaturates, particularly naphthalene and anthracene, were selected as raw materials. Constant experimentation had developed high-grade (and equally high-priced) rubber blacks by the early 1930's. By 1938 the extent of such production was readily indicated by analysis of Germany's natural rubber vs. carbon black imports, the former rising some 50% over 1935 despite increasing production of elastomers and the latter remaining static. Production of the higher-priced domestic blacks was supported by governmental restrictions on the importation of American blacks, it being imperative that Germany develop synthetic rubber and substitute blacks as well as synthesized fuels for her mobile units.

In this country experimentation with electric arc production was carried on in the early 1920's by the U. S. Bureau of Mines, the results being published in 1924 as Technical Paper 351, "The Electrical Manufacture of Carbon Black," by Dr. J. J. Jakosky. His determinations indicated that, given cheap light oil supply and cheap electric power,

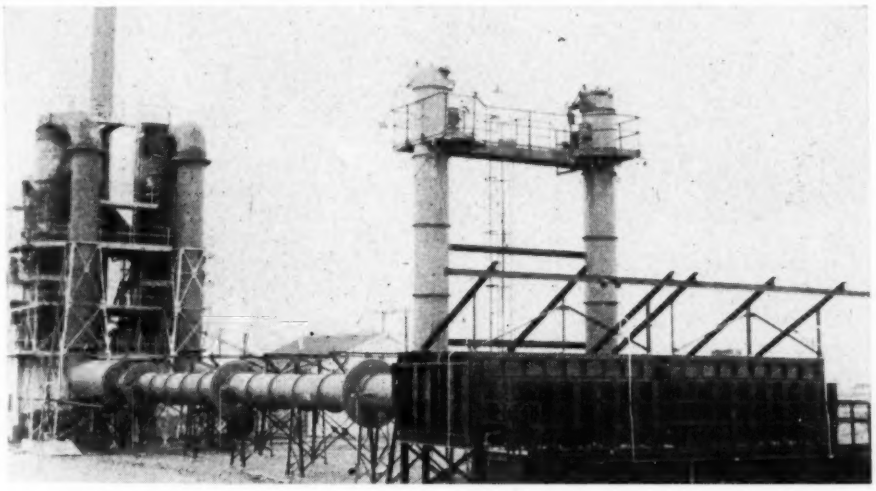

Fig. 5—(Above) Complete Gastex unit. Furnaces and air intake stacks in foreground, precipitators and collectors in background

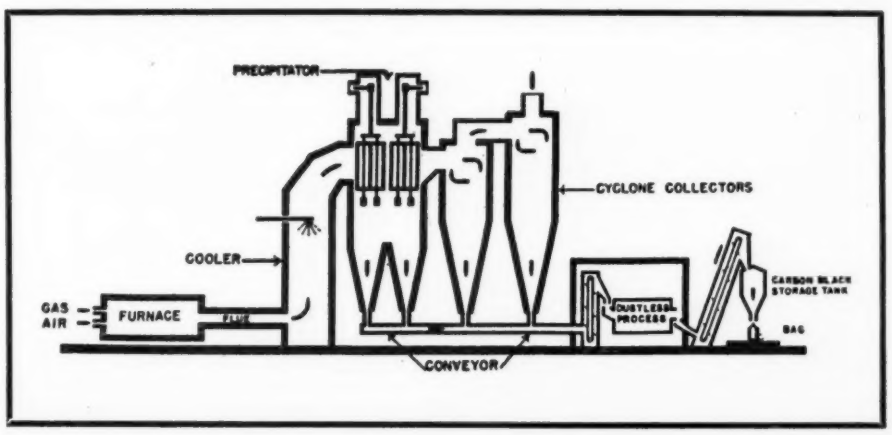

Fig. 6—(Right) Diagram of furnace process using Cottrell precipitators for collecting the carbon black product

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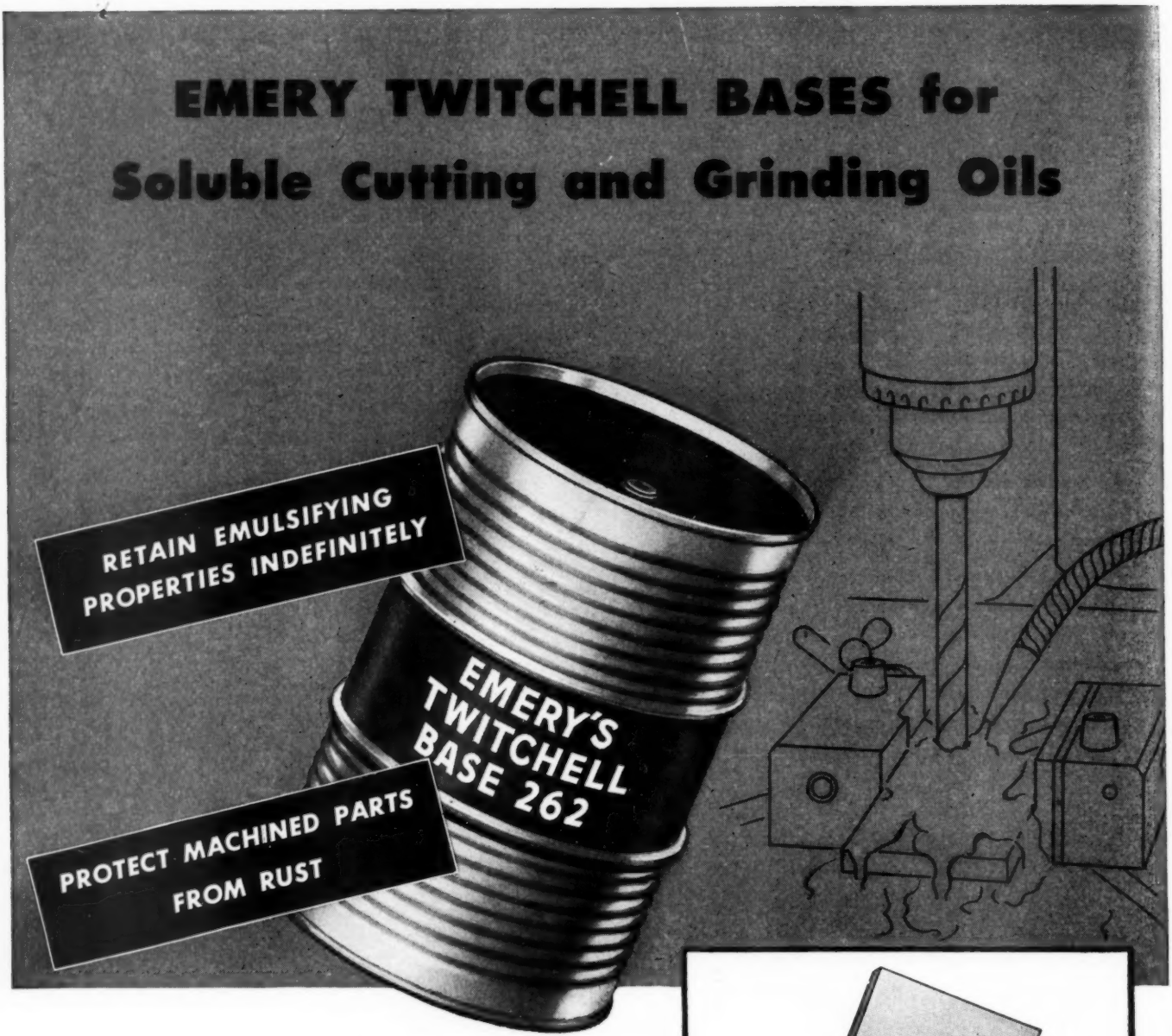

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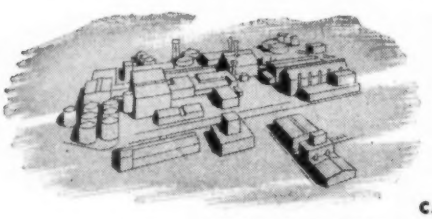

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blacks not notably inferior to those produced with natural gas could be manufactured at a cost in excess of 10c per lb. He obtained blacks of varying qualities from kerosine, gas oil, gasoline, naphtha, benzol, creosote, alcohol, pine-tar oil, fuel oil, and transformer oil. Where using oil, he also obtained gas, ethylene, and propylene as decomposition by-products, suggesting that sale of these could serve to lower the high cost of manufacture.

It should be noted that the production of impingement type black from raw materials other than natural gas has in no instance invaded the economic field, and that in few cases have equivalent or near-equivalent blacks been obtained. In view of the product's latter-day utility, its sales price is undeniably too low; however, this is but a reflection of lowered unit production cost and intense competition. There are three facets of this economic problem which bear closer inspection in the consideration of the end use of natural gas in the production of carbon black: (1) reserves, availability, and utility of natural gas; (2) price of natural gas at the wellhead, which is dependent upon (1); and (3) utility of carbon black, of itself sufficient to justify production almost without regard to (1) and (2).

Manufacturers in Economic Difficulty

In retrospect it is ironical that carbon black manufacturers, having assigned value to natural gas by establishing its utility, and having thereby fostered the development of additional reserves through the gas market made available to producers, have repeatedly found themselves economically unable to compete for those reserves with the pipe line companies which have followed in their wake. In the early days of the industry this was a matter of small concern, inasmuch as the largely prefabricated carbon black units could be moved without great difficulty to another more remote gas supply, again providing an incremental income, however slight, for producers therein.

Today, however, the gas utilities have acquired holdings in all major producing areas and have projected giant pipe lines to tap those sources for distant markets. Gas prices are tending to equalize, and carbon black units have thereby essentially lost their mobility. No longer is there a price differential sufficient to defray moving expenses. Even sour gas supplies are not secure, efficient desulfurization units capable of sweetening gas for perhaps 0.5c per MCF having made it more economic for pipe line systems, with greater throughput, to take this gas than for carbon black manufacturers to do so.

As suggested earlier, the price of natural gas at the wellhead is dependent upon the combined factors of reserves, availability, and utility. From the foregoing, it is readily apparent that it is utility which is the determinant. Reserves have increased tremendously, and, by inference, availability has also. Even apart from reserves, unabated flareage furnishes another measure of availability, this time in terms of excess. Increased reserves and availability might logically have been expected to result in decreased cost, yet the price of gas has continued to rise as it has found added utility.

Wellhead Price Higher—Not Value

This is obviously the result of a competitive economy in which an increased margin of profit has permitted the assignment of a higher wellhead price—not value—to natural gas, first by the utilities and subsequently by technologists. The writer finds himself woefully unable to agree with the concept of value expressed by E. P. Schoch in a Bulletin of the University of Texas in 1945:

"It is important to make valuable rather than cheap products—that is, products which add a large manufacturing value per pound of raw material. The importance of a raw material naturally increases as more of the high valued products are made from it. Thus clays become more important as more and more of the finer products—chinaware and art ware, rather than common bricks—are made from it. With coal tar, it is the dyes and pharmaceuticals rather than tar roofing which give it its importance.

"Similarly, in dealing with methane, we must seek to make plastics and rubber rather than gasoline—because in making gasoline the value of the natural gas used is likely to be doubled only, but in making plastic or rubber the value of the gas used will be multiplied by 40."

To reiterate: price, not value, has been increased. The value of the gas used has not been multiplied by 40, but an artificially high price has been perpetuated for the finished product, this permitting establishment of a higher price for raw material. If the use of natural gas in the production of high-priced goods permits a 40-fold profit, then the cost of those goods should be lowered. Under the free enterprise system it is not necessarily the man who builds a better mousetrap who succeeds but those who build at least an equally good cheap mousetrap.

Dr. Schoch speaks ill of the production of gasoline from methane, the principal component of natural gas. With this view the author is in complete accord, not necessarily in that such production will no more than double the value of the raw material, but in that

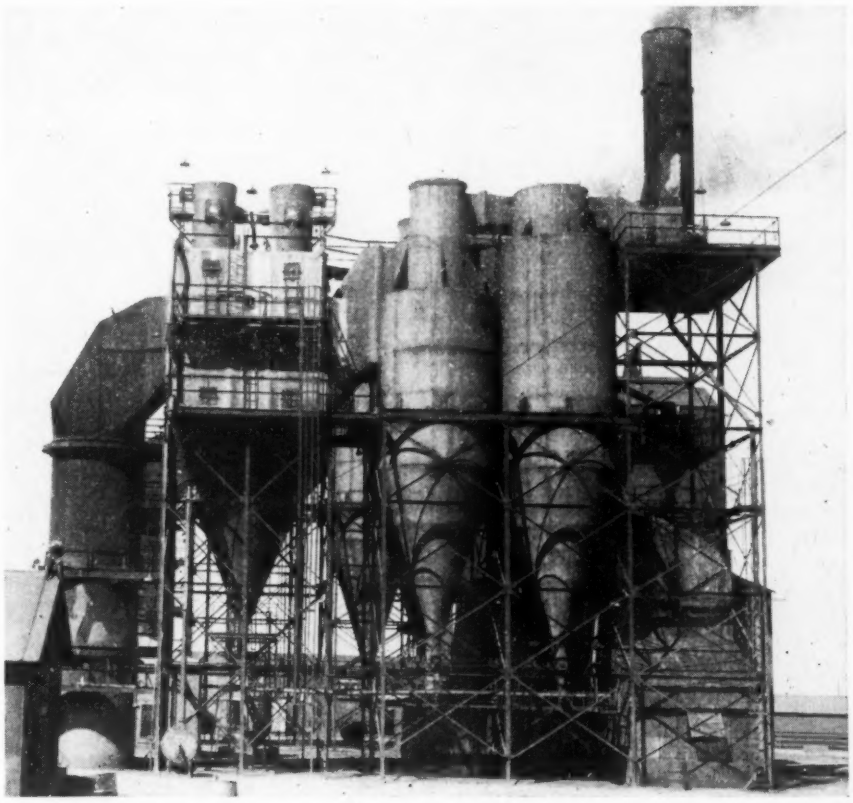

Fig. 7—Close-up view of Cottrell precipitators and cyclone separators used in the Cabot Carbon Co. collector system

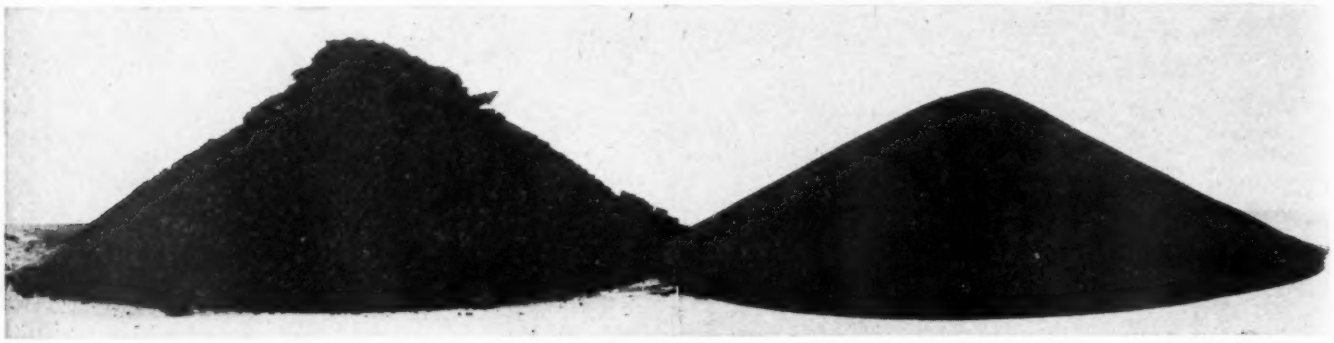

Fig. 8 — Heavy compressed carbon black (left) and an equivalent weight of Cabot Spheron (right), a dry process pelletized black

such gas had far better be used in the interest of the public for the production of carbon black.

This is demonstrated very simply: It is held possible to make a barrel of gasoline from 10,000 cu. ft. of gas. It is actually a barrel of gasoline-fuel-heavy-oil mixture which is so obtained, the gasoline yield presently being more nearly 1:13,000. Accepting the feasibility of the higher yield, however, it is still only sufficient to take a light car, capable of making 20 miles per gallon, a total of 840 miles. The same quantity of gas, even if burned in the so-called "wasteful" channel process of manufacture, will yield 14 pounds of carbon black, or sufficient for compounding in four natural rubber tires capable of taking the same car 20,000 miles farther than would otherwise have been possible.

Industry Struggles to Secure Gas

If the "value" of natural gas is doubled in the production of gasoline, then it is by simple mathematics nearly 48 times as great in the production of carbon black—greater even than in the production of the vaunted plastics and rubber. Yet today a commercial installation for the production of gasoline from natural gas, at 5c per MCF, is being constructed in the Carthage field of East Texas, while the carbon black industry is struggling to secure gas for a finished product which until recently had a gross sales value less than this raw material cost alone.

What is wrong here? Very simply, the time element has upset the economic apple-cart. To set it straight, one need only adapt the events of World War I to World War II, assuming that the tire industry has been static for this past quarter of a century. The cord tire, developed before the whole world was thrown into conflict, had given compounders a tire carcass which outlasted the tread, and the price of zinc oxide, whose reinforcing properties even earlier permitted manufacturers to place a 3,000 mile guarantee on tires, had risen sharply during wartime. Compounders thus were given a dual reason for experimentation with new reinforcing pigments.

The British, first to use lampblack as a rubber compounding pigment, were also first to use carbon black as a reinforcing agent. In 1914 the Goodrich Tire & Rubber Co., which had secured British know-how through merger, released its supplier of carbon black from secrecy concerning its use in tires. As a result, all American manufacturers started experimenting with this new compounding ingredient.

Four years later, in 1918, the war was over, yet experimentation with this "war-baby" was still feverishly continuing. To that time too much stress had been placed upon the vulcanization procedure. Carbon black production had just reached a peak of 50 million pounds annually. Three years after the war's end, compounders attained their initial goal, and proudly announced 10,000 mile guarantee to supplant the old 3,000 mile one. Simultaneously the price of carbon black reached an average price in excess of nine cents a pound, with a top rubber price some two or three times higher.

Returning abruptly to the present, is there any reason to doubt that the product which made possible the 10,000 mile guarantee, which subsequently permitted the development of tires capable of going 30,000 miles, safely, and which thus fostered a revolution in automotive engineering design, can hold its own in the new gas technology? After all it is the cornerstone of that technology, representing as it does the product of the simplest of those reactions into which methane, the principal component of natural gas, enters.

The sales price of carbon black is obviously no measure of its value or utility. If it were, the cost of tires and of carbon black would have been doubled, trebled or even multiplied by ten. Yet this latter-day utility might never have been discovered without cheap black, made possible by cheap gas, and America's annual tire bill might well be an additional $50,000,000. And the same cheap gas even earlier made possible that cheap black which permitted expansion of the nation's printing and publishing industries, which have together made Americans the most literate of the world's peoples.

Most Durable Finish Made Possible

Cheap gas, again made possible the most enduring of all finishes—black paint—with which the bulk of the nation's automobiles are painted and the merits of which are all too evident in this post-war year when evanescent reds, blues and greens, the rust showing through their faded hues, are everywhere reflected by glossy black finishes; when, too, words or lines of black lettering stare starkly down from signs made meaningless by dimming or disappearance of accompanying varicolored phrases.

These are but the main uses of a product whose utility is manifold but they are the uses for which 97% of all production is destined. The remaining 3% enters into such varied uses as plastics, paper, metallurgical processes and dry cells—even into such unlike and in part unseemly uses as the reinforcement of concrete, the darkening of bittersweet chocolate candy, the decolorization of sugar, and the coloration of barren soil, in at least one real esate scheme, to simulate fertility. This, then, is carbon black, with its uniquely uneconomic economic history. *It need only be remembered that the low price paid for natural gas at the wellhead established the low price received for carbon black, not the converse, and that this price, although it permitted the establishment of the product's basic utility in rubber compounding, is in itself no measure of that utility.*

Carbon Black Suggested Additional Reading

For a more extended treatment of carbon black the reader is referred to Isaac Drogin's "Developments and Status of Carbon Black," privately published in February, 1945, by the United Carbon Co., Charleston, West Virginia. Also of interest is Leonard H. Cohan's "Carbon Black in War and Peace", published in the Nov. 25, 1945 issue of *Chemical and Engineering News*, and dealing primarily with the nature and properties of carbon black; this article contains a bibliography of more than a hundred additional references.

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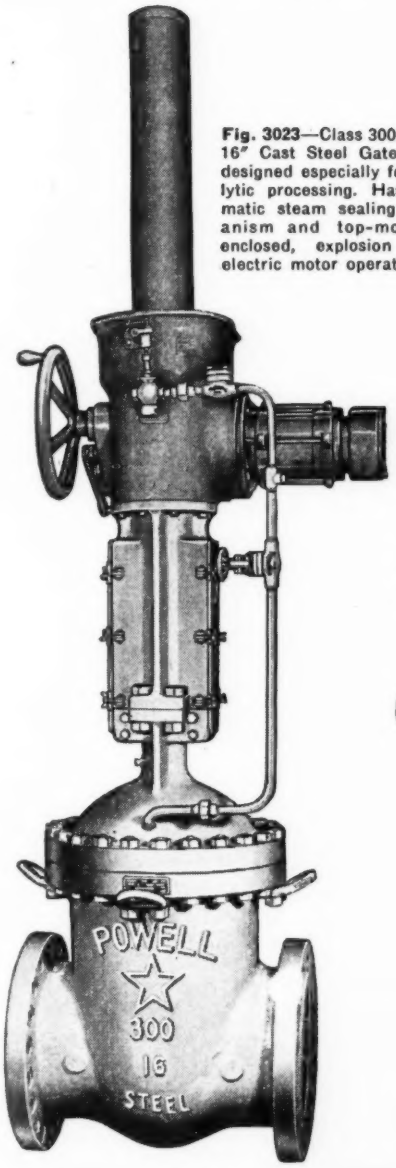

Fig. 3023—Class 300-pound, 16" Cast Steel Gate Valve, designed especially for catalytic processing. Has automatic steam sealing mechanism and top-mounted, enclosed, explosion proof, electric motor operator.

Fig. 375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet, and renewable, wear-resisting "Powellium" nickel-bronze disc.

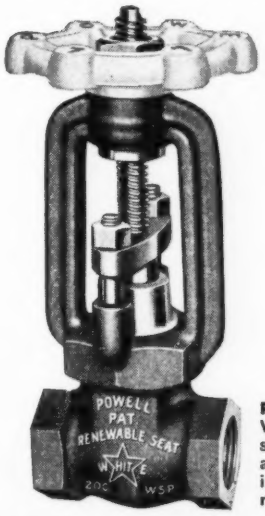

Fig. 386—200-pound Bronze Gate Valve with screwed ends, outside screw rising stem, screwed-on yoke and bonnet, renewable wear-resisting "Powellium" nickel-bronze seat rings and taper wedge solid disc.

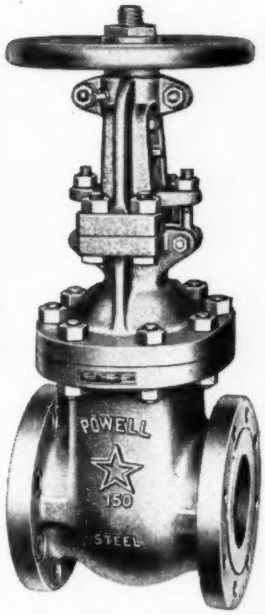

Fig. 1503—Class 150-pound Cast Steel Gate Valve with bolted flanged yoke, outside screw rising stem and taper wedge solid disc. Powell Cast Steel Valves of all types are available in pressure classes from 150 to 2500 pounds, inclusive.

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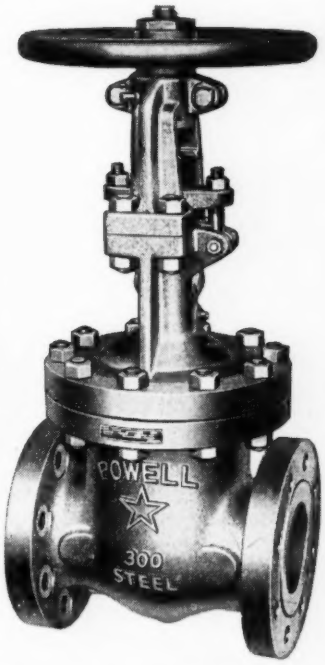

Fig. 3003—Class 300-pound Cast Steel Gate Valve with bolted flanged yoke, outside screw rising stem and taper wedge solid disc.

POWELL VALVES

Catalytic Desulfurization Octane Improver for Many Straight-Run Gasolines

Review of paper entitled "Evaluation of Sulfur Compounds in Gasolines", by F. C. Moriarty, Universal Oil Products Co., presented before National Petroleum Assn., Atlantic City, Sept. 19, 1946.

SELECTION of sulfur removal methods by refiners based on a careful study of their existing gasoline treating processes, and giving consideration to the likelihood of their processing higher sulfur bearing crudes in the future may postpone expensive changes in refinery processing units.

Cracked gasolines are high in mercaptans and cyclic sulfur compounds, low in thermally unstable sulfur compounds and therefore are best treated by mercaptan extraction methods.

Catalytic desulfurization processes are recommended for straight-run gasolines which contain more of the thermally unstable mono and disulfides and less of the cyclic compounds. Octane value is improved for straight-run gasolines by this method. The improvement is believed to be caused by some degree of isomerization as well as by sulfur removal itself.

Anticipated increases in postwar octane levels of gasolines will be expensive for refiners to achieve and they should analyze their existing gasoline treating processes, particularly for sulfur removal, with a view to improving octane number or eliminating octane losses, it is brought out.

Many operators have valuable untapped resources in their treating plants which, if utilized, will postpone the day when it becomes necessary for them to make extremely expensive changes in their refinery processing units.

"Many refiners who in the past processed sweet crudes are now faced with the importation of high sulfur crudes, as our largest reserves and newest crude discoveries are high in sulfur", Mr. Moriarty stated. "For this reason there are few refiners today who are not either charging high sulfur crudes, or making plans to process such crudes in the future."

Generally speaking, there are three reasons for reducing sulfur content of gasolines, it is pointed out. They are (1) to improve odor, (2) to meet specifications limiting total sulfur, and (3) to improve certain properties, particularly tetraethyl lead susceptibility.

Mr. Moriarty evaluated sulfur compounds in gasoline and presented a basis for establishing sulfur treating procedures.

"A laboratory report, listing only 'total sulfur'", Mr. Moriarty said, "is of little use in reaching an intelligent decision involving treating matters, yet total sulfur is frequently the only analysis available. There are many sulfur compounds in gasolines, and they have widely divergent chemical properties. Some are acidic, some are corrosive, and some are harmful to octane number."

On the other hand, complete and detailed analyses for sulfur compounds are time consuming and impractical for any but research problems, he believes. For both straight-run and cracked gasoline, hydrogen sulfide, mercaptan, and total sulfur determinations are required and easily obtained. In addition it is usually worthwhile to make a catalytic desulfurization test for straight-run gasolines.

Three Types of Sulfur Compounds

The various sulfur compounds in gasoline fall into three groups:

1. Acidic type: hydrogen sulfide and mercaptans.

2. Neutral, but thermally unstable; mono and disulfides.

3. Thermally stable: cyclic compounds such as thiophenes.

Straight-run gasolines usually contain only Groups 1 and 2 compounds. The Group 1 compounds, hydrogen sulfide and mercaptans, can be determined directly in the laboratory. If the gasoline is catalytically desulfurized, the Group 2 compounds which are thermally unstable, will be decomposed to hydrogen sulfide, and in this manner the Group 2 sulfur content can be determined. Any remaining sulfur can be classified as Group 3, although straight-run gasolines do not normally contain appreciable quantities of the compounds in Group 3.

In fresh, that is to say unoxidized, samples of cracked gasoline, sulfur compounds will be predominately those of Groups 1 and 3, or hydrogen sulfide, light mercaptans, and cyclic sulfur compounds. Since Group 2 is usually not present in appreciable quantities in raw cracked gasoline, Group 3 can be determined by difference, assuming the hydrogen sulfide and mercaptan content is known. The absence of Group 2 compounds in cracked gasoline can probably be explained by the fact that these are thermally unstable. If originally present in the charging stock, they would have been changed under the high temperature conditions of the cracking process to form sulfur compounds of Group 1 or 3. In fact, Group 3 sulfur compounds seem to be associated principally with cracked products.

After the above classifications have been made in terms of actual percentages, for either cracked or straight-run gasolines, it becomes a simple matter to choose a process suited to the individual gasoline.

Group 1 and 2 compounds are harmful to TEL susceptibility. The removal of Group 3 compounds to increase this property is not justified unless it is necessary to meet sulfur limitations.

Summarizing the treatments for cracked gasoline, the author said some form of mercaptan extraction is recommended, either caustic scrubbing or processes such as Unisol. These remove hydrogen sulfide most economically, and the mercaptan extraction usually results in a slight increase in octane number. Copper or doctor sweetening should not be used, except where the initial mercaptan content is very low and a negative doctor test is required. The danger is that the sweetening process in the presence of high mercaptan content causes an octane loss, because no sulfur is removed and the disulfides formed are somewhat more deleterious to octane than the original mercaptans present.

Straight-run Treatment

In the summary of treatments for straight-run gasoline, catalytic desulfurization is recommended where preliminary laboratory catalytic desulfurization tests indicate sufficient octane improvements to justify the operating cost. In those cases where the gasoline is of low end point, containing essentially all mercaptans, a mercaptan extraction process should be used. For extremely low sulfur straight-run, little octane improvement is possible, and usually a simple caustic washing unit or a sweetening unit is desirable, depending on whether a negative doctor test is a requisite.

Catalytic desulfurization on straight-run gasoline will usually show a marked improvement over mercaptan extraction because it removes both mercaptans and Group 2 compounds. Since these gasolines seldom contain appreciable quantities of Group 3 compounds, sulfur removal is almost complete. A factor which contributes largely to the octane improvement by catalytic desulfurization is the isomerization which it is believed takes place. Numerous data on this process do not account for octane improvement on the basis of sulfur removal alone, and

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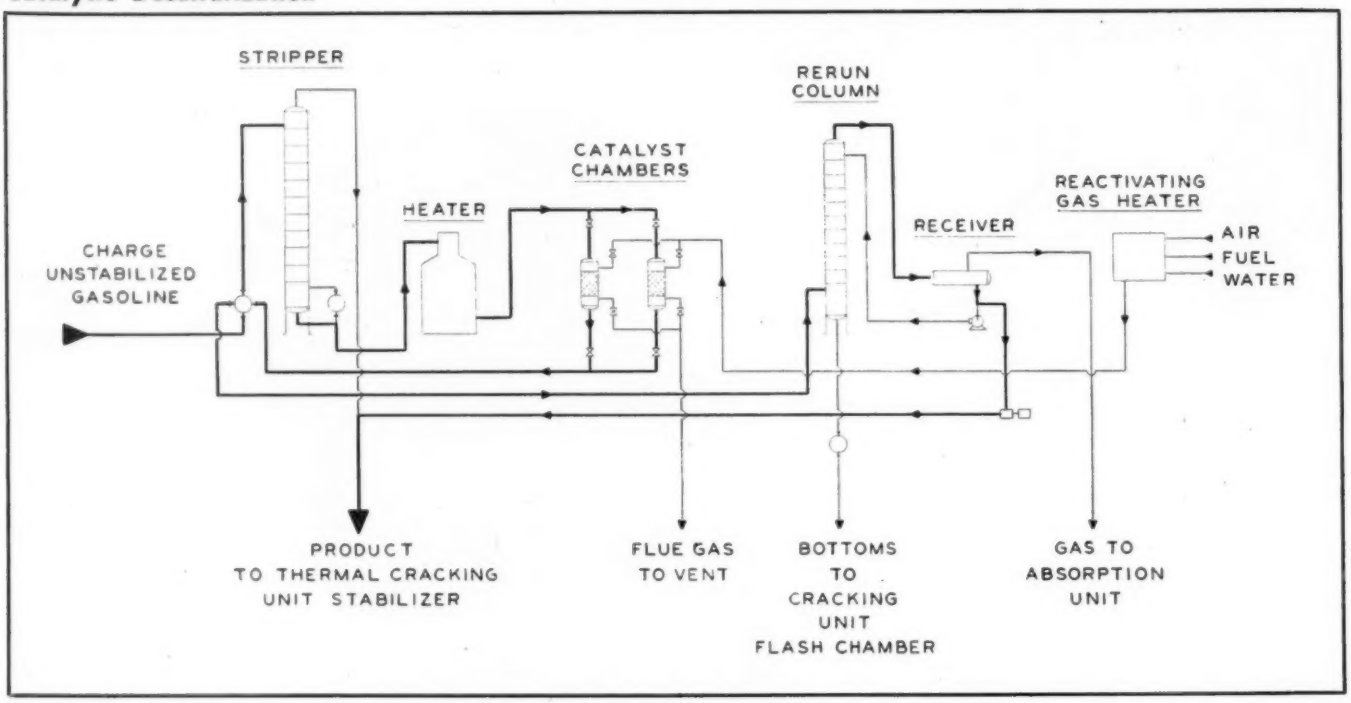

Flow diagram for the Isoforming process, used to improve the octane rating of thermally cracked gasolines, alone or blended with straight-run. Although carried out in a manner similar to catalytic desulfurization, it is said to overcome two disadvantages of the latter type of process—polymerization and catalyst coking. This is accomplished by employing an active catalyst at extremely high space velocity

point to some degree of isomerization as a factor.

On the other hand, catalytic desulfurization is not economically sound for cracked gasolines. The reason for this is that fresh, untreated cracked gasolines usually contain only mercaptans and relatively stable Group 3 cyclic compounds like thiophene. The process does not decompose cyclic sulfur compounds and the mercaptans can be removed by the less costly extraction methods.

Further, desulfurization catalysts have a relatively short life due to carbon deposition when processing cracked gasolines, adding materially to operating costs because of necessary frequent regeneration. In addition, polymerization occurs in the presence of the desulfurization catalyst, and rerunning is required. This polymerization loss may reach several per cent.

"In studying laboratory results from desulfurization work on cracked gasolines", Mr. Moriarty warned, "it should be remembered that the product has usually been rerun to produce a slightly lower boiling range, which may result in what appears to be a slight improvement in octane gain over mercaptan extraction. Comparative studies should be based on products of the same boiling range."

Returning to straight-run gasolines, the case for catalytic desulfurization can be made very strong. Frequently severe reforming can be avoided. The processes, particularly high temperature clay and Unisol treating, are not appreciably affected by changes in sulfur content of the charging stock. "In other words, a switch can be made from extremely low sulfur to high sulfur crude without changing the treating equipment," said Mr. Moriarty. "The West Texas crudes, for example, are so high in sulfur that many of the older processes, such as doctor and copper sweetening fail miserably in processing them."

Describes Isoforming Process

The speaker then described the Isoforming process, which is used to improve the octane number of thermally cracked gasolines or blends of thermally cracked and straight-run gasoline. Carried out in a similar manner to catalytic desulfurization, the process minimizes polymerization and catalyst coking by employing an active catalyst at extremely high space velocity, so that the reaction is completed and the material removed from contact with the catalyst before polymerization and coking can take place to any great extent.

More important than the actual octane number improvement is an improvement in blending octane number. The first may be as high as 3 to 6 points, while the latter may be as much as 10 points. Some desulfurization takes place, but it is felt that the principal advantage is in the isomerization that occurs.

Catalyst regeneration is necessary with isoforming but is not difficult as the amount of catalyst in the plant is small. A 1000 b/d plant uses about 1400 lbs. of catalyst in two vessels, alternately on process and regeneration, and only 10 to 20 lbs./hr. of coke is burned. By comparison, catalytic desulfurization units require 10,000 to 20,000 lbs. of catalyst for a 1000 b/d charge.

Optimum results in Isoforming are said to be obtained at the lowest practical operating pressure, but high temperatures in the order of 950° F. are used. Carbon formed on the catalyst amounts to about .1 to .2% by weight of the charge. Total process loss—gas, polymer, catalyst deposit—amounts to 2 to 4%.

Isoforming is described as competitive with Unisol treating on some cracked gasolines having an appreciable mercaptan content for, although its installation costs are greater, often more is to be gained through its use. Unisol will not show much improvement on low mercaptan gasolines, while Isoforming may show its greatest improvements on this type of stock. On the other hand, Unisol treating of some high mercaptan gasolines may give leaded octane improvements nearly as great as will Isoforming.

Previous Articles on Sulfur Treating

"Catalytic Desulfurization Improves Lead Susceptibility of 'Sour' Distillate." National Petroleum News, *Technical Section*, April 4, 1945, page R-309.

"Hydroforming—A Catalytic Method for Naphtha Upgrading," by Hill Vincent, and Everett, National Petroleum News, *Technical Section*, June 5, 1946, page R-456.

"Catalytic Process Is used in Desulfurizing Stocks", Petroleum Processing, October, 1946, page 89.

Commercial TCC Unit Operates On Partially Vaporized Stocks

Improved Design of Concurrent Flow Provides Better Heat Utilization with Negligible Carry-Over of Catalyst Fines

Review of paper entitled "Commercial TCC Operations on Partially Vaporized Charge Stocks," by H. D. Noll, A. W. Hoge and D. M. Luntz, Houdry Process Corp., Presented before National Petroleum Association, Atlantic City, Sept. 19, 1946.

REVAMPED to process both vaporized and partially vaporized charge stocks, and using concurrent catalyst and oil flow through the reactor, a Thermofor Catalytic Cracking unit has been in successful operation since March, 1946, at Paulsboro refinery of the Socony-Vacuum Oil Co. Changes in the existing TCC unit, costing only about 1% of the initial investment, include a specially designed vapor-catalyst disengager (necessary for concurrent flow), alterations in the external piping system to permit concurrent flow, and the installation of special liquid and catalytic distribution equipment in the reactor.

Data from the commercial operations indicate that concurrent flow results in better heat utilization in the reactor than countercurrent flow as is now practiced in most such units throughout the country. An average reactor temperature approximately 50° F. higher was obtained in concurrent operation for catalyst and oil inlet temperatures of 1000° F. and 900° F., respectively, and for catalyst slant oil ratios in the neighborhood of 2:1. The higher average reactor temperature results in higher octane number gasoline, about 1 to 2 numbers CFR-M and 2 to 3 numbers CFR-R.

Catalyst Carryover Negligible

Discussing the mechanical efficiency of the unit, the authors said, "Carryover of catalyst fines to the synthetic crude tower is negligible. The vapor-catalyst functioned in a completely satisfactory manner at reactor throughputs equivalent to 100 b/d of hydrocarbon charge per sq. ft. of reactor cross-section.

"During the mixed phase operation, analyses of spent catalyst samples taken across the first reactor draw-off plate showed uniform coke laydown. This indicates that all of the catalyst was functioning with equal effectiveness.

"The pressure drop across the reactor and disengager is such that reactor seal legs in existing countercurrent TCC units are adequate for concurrent operations. There was no breakup of catalyst in the concurrent operation."

Paulsboro First Used for Retreating

The catalytic section of the Paulsboro TCC unit is composed of a 16 ft. I. D. solid-bed reactor and a 10-zone, 10 ft. square, solid-bed kiln with a nominal catalyst circulation rate of 100 tons/hr. The plant was first placed in operation in 1944 and until the end of the war was utilized chiefly for reteating first-pass Houdry motor gasoline to high quality aviation base stock at charging rate in the neighborhood of 10,000 b/d. Immediately following the war, the unit was operated without any design changes on gas oil cracking for motor gasoline. Modifications were made early in 1946 and since that time various vaporized and partially vaporized charging stocks have been processed with the concurrent flow operation, using a synthetic bead catalyst.

The Alterations Made

The alterations on the reactor are shown diagrammatically in Fig. 1, and are as follows:

1. The external oil piping was reversed so that fresh vaporized charge entered the reactor at the top, at the previous oil outlet nozzle, and synthetic crude vapors left the reactor at the bottom, via the previous oil inlet nozzle.

2. A vapor catalyst disengaging device was installed in the lower section of the reactor, utilizing part of the previous vapor distributing device to support the disengager.

3. The catalyst distributing system in the top of the reactor was devised to the extent that a portion of the catalyst (about 80 tons/hr.) was introduced through a central feed pipe and over a conical deflector from which it fell in an annular curtain to the catalyst bed. The remainder of the catalyst was fed into a single peripheral row of feed pipes in the conventional manner.

4. The reactor was equipped with a fog nozzle for injecting non-vaporized charging stocks.

No other changes were required. The existing spent catalyst purging system was satisfactory and no vapor distributing system was needed at the top of the reactor.

Commercial runs at Paulsboro included two test periods on vapor phase operation and a test period on mixed phase operation. Table 1 summarizes the operating data on these runs.

Vapor Phase Operations

In vapor phase operations the fresh oil charge, together with a recycle stream from the synthetic crude tower, was vaporized in a primary furnace, superheated in a second heater to the desired temperature, and then charged to the reactor. A small amount of the light distillate fuel side stream from the fractionator was supplied to the tar separator, from which it passed overhead to become a portion of the reactor vaporized charge. Oil vapors, after passing through the reactor, flowed to the synthetic crude tower where gasoline and gas were taken overhead. As mentioned above, part of the light distillate fuel was returned to the reactor via the tar separator while the remainder was taken as product.

The high liquid recoveries realized from both vapor phase tests shown in Table 1 are characteristic of TCC cracking. For these runs, with conversions of 67-68%, the recoveries of C_4 and heavier material were 99-100%.

Better heat utilization for concurrent than for countercurrent flow results because all of the heat content of the inlet catalyst stream contributes to the reactor bed temperature. In a countercurrent system essentially all of the differential heat in the catalyst stream above the average reactor bed temperature is lost to the effluent vapor. With the same average temperature in both types of reactors, a temperature pattern shows lower maximum and higher minimum temperatures for concurrent flow, thus providing a closer approach to the ideal iso-thermal temperature pattern. Moreover, because the catalyst heat is carried into the reactor, a higher average reactor temperature may

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TABLE 1—Results of Commercial Runs at Paulsboro TCC Unit with Both Vapor and Mixed Phase Concurrent Operation

Run Number	A-2	A-3	B-2
Type	Vapor	Vapor	Mixed
Charge Stock	Paraffinic	Gas Oil	Heavy Iowa* Gas Oil
Bead Catalyst, Activity Index	36.6	35.9	35.6
Fresh Liquid Feed, b/d	....	....	1840
Fresh Vapor Feed, b/d	9127	7895	7720
Lt. Dist. Recycle, b/d	1120	847	145
Total Feed, b/d	15975	12946	9705
Process Steam, lbs./hr.	nil	8800	nil
Process Steam, % wt. Total Chge	nil	5.4	nil
Purge Steam, lbs./hr.	3030	2405	3955
Catalyst Rate, tons/hr.	108	122	120
Space Velocity, Total Feed, V/hr/V	1.69	1.37	1.03
Catalyst/Oil ratio, V/V	1.22	1.71	2.25
Oil Vapor Inlet Temp., °F.	866	855	890
Oil Vapor Outlet Temp., °F.	842	821	819
Oil Liquid Inlet Temp., °F.	....	....	673
Catalyst Inlet Temp., °F.	955	900	967
Pressure, Inlet, psig	10.7	10.7	6.6
Pressure, Outlet, psig	8.4	7.3	5.2
Carbon Burned, lbs./hr.	4000	4800	3800
Conversion, % vol.	67.6	67.1	49.9

Run Number	A-2	A-3	B-2	
Type	Vapor	Vapor	Mixed	
Charge Stock	Paraffinic	Gas Oil	Heavy Iowa* Gas Oil	
Yields on Fresh Feed:				
10 lb. RVP Gasoline, % vol.	55.5	53.5	45.5	
C_4 Free Gasoline, % vol.	52.7	50.5	42.6	
Cycle Stock, % vol.	32.4	32.9	50.1	
C_4H_8, % vol.	3.9	3.9	2.7	
i-C_4H_{10}, % vol.	7.6	8.5	4.7	
n-C_4H_{10}, % vol.	3.2	3.0	2.0	
Total C_4's, % vol.	14.7	15.4	9.4	
Liquid recovery, (C_4 & heavier)	99.8	98.8	102.1	
Dry Gas, % wt.	6.2	5.8	3.9	
Coke, % wt.	3.5	5.3	3.0	
Inspection of Fresh Charge:			Vapor	Liquid
Gravity, °API	34.1	33.8	27.4	20.8
IBP, °F.	395	540	472	555
10%, °F.	511	552	548	659
50%, °F.	590	612	640	864
90%, °F.	672	701	817	CRKD
EP, °F.	714	730	...	1050+ (Est.)
Aniline Point, °F.	172	170	155	187
Sulfur, Wt. %	0.32	0.29	0.31	....
Conradson Carbon, Wt. %	0.02	....	0.01	1.0 (Est.)
Inspections of 10 lb. RVP Gasoline				
Octane Number, CFR-M, clear	80.0	79.3	79.8	
+3 cc. TEL.	87.9	88.2	87.1	
Octane Number, CFR-R, clear	89.9	88.2	88.4	
+3 cc. TEL.	97.1	95.5	96.2	
Sulfur, Wt. %	0.017	....	0.041	

* Coastal Louisiana.

NOTE: The information in this table was condensed from Tables 1 and 2 of original paper.

be achieved at given oil and catalyst inlet temperatures with concurrent flow.

This means that existing countercurrent TCC units may be converted to concurrent operation with substantial savings in fuel costs if it is desired to crack at the same average reactor temperature. The excellent heat utilization is illustrated by the high conversion rate of 67.6% attained in Test A-2 (Table 1) when operating at only 1.22 catalyst/oil ratio. Such a low catalyst rate is not proposed as optimum for TCC cracking but is merely included to show what can be done by concurrent flow.

It was found that the purging problem was simpler in concurrent flow because the material absorbed on the catalyst is the highest boiling fraction of cycle stock rather than the highest boiling fraction of the fresh charge, and thus has a lower molecular weight.

In several tests (e.g., A-3 in Table 1) the flow of hydrocarbon vapors plus steam was equivalent to a flow of hydrocarbon vapors alone of about 100 b/d per sq. ft. of reactor cross section, showing that the vapor-catalyst disengager is effective at throughputs at least as great as will be encountered in most commercial reactors. This means that the smallest existing reactors, 11 ft. 5 in. I.D., could process the equivalent of 10,000 b/d of charge.

Since the reactor seal leg on the Paulsboro unit is similar in design to those installed on previous units, and since the operation was satisfactory at throughputs of 100 b/d per sq. ft. of reactor cross section, it was demonstrated that catalyst seal legs on existing units are adequate for concurrent operation.

Mixed Phase Operations

Test Run B-2 (in Table 1) summarizes the data from a mixed phase test. In this test, fresh charge was preheated to 793° F.

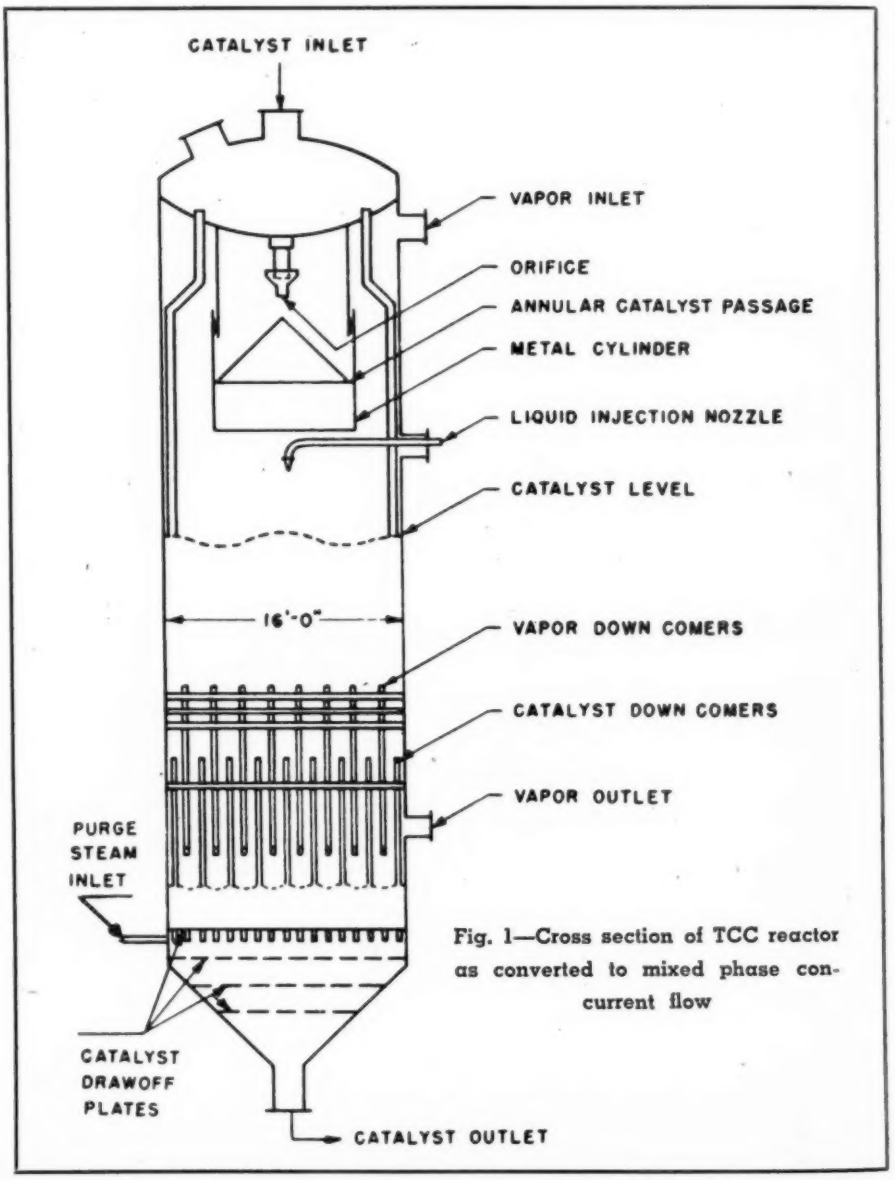

Fig. 1—Cross section of TCC reactor as converted to mixed phase concurrent flow

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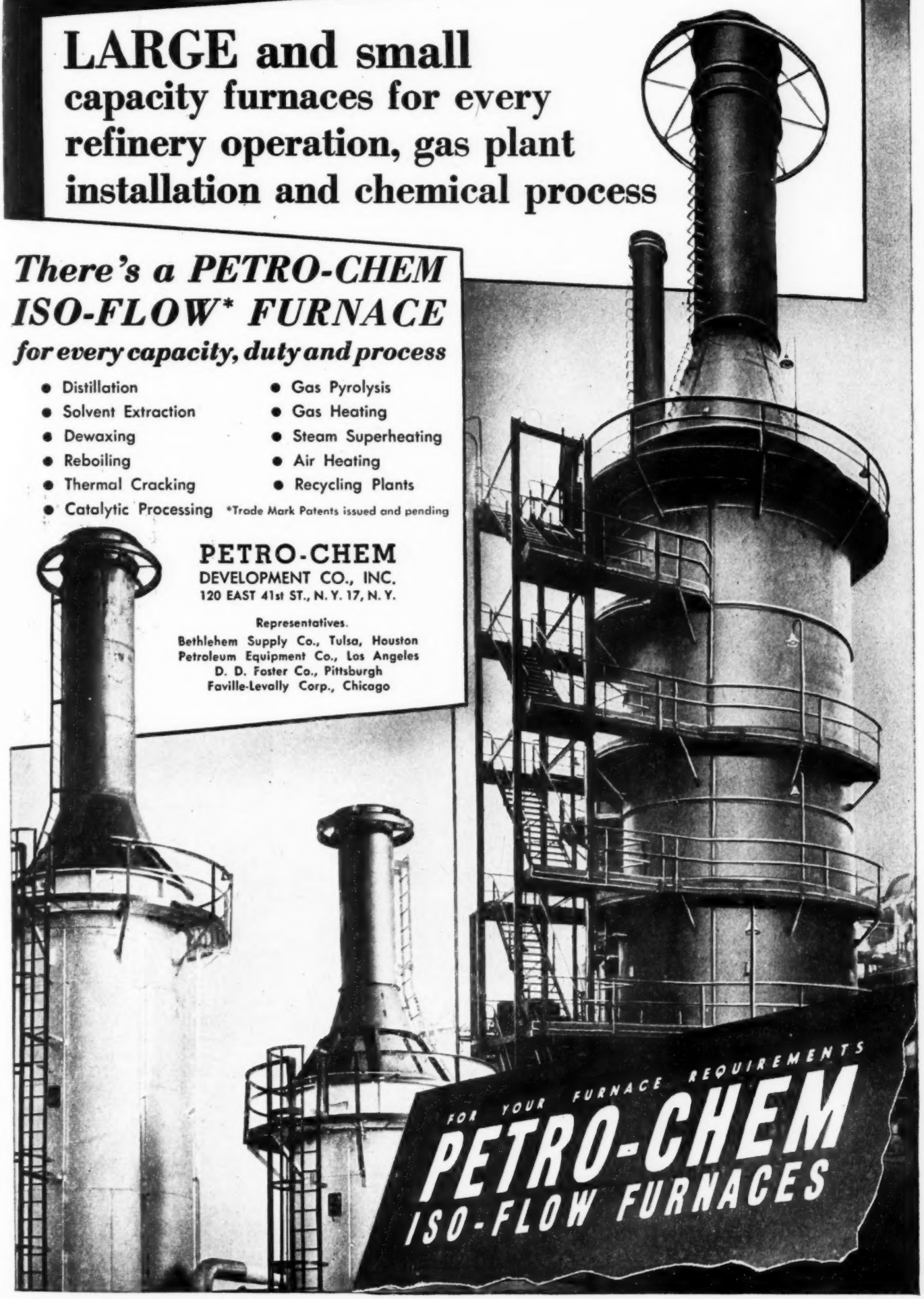

TABLE 2—Carbon Concentration on Spent Catalyst on First Draw-off Plate

Distance From Shell, ins.	Wt. % Carbon on Catalyst
6	3.0
18	2.6
30	2.4
42	2.3
54	2.4
66	2.9
78	2.5
90	2.7

and flashed in a tar separator, 81% going overhead. This overhead (including a small amount of light distillate recycle) was superheated to 890° F. and charged to the reactor at the vapor inlet. The tar separator bottoms were charged to the reactor as a liquid (at 673° F.) through the fog nozzle.

The low coke and dry gas yields (3.0 and 3.9 wt. %, respectively) from the mixed phase test are noteworthy, especially when it is considered that 45.5% of 10 lb. RVP gasoline was made. Also of considerable interest is the 102% liquid recovery.

TABLE 3—Pilot Plant Comparison of Once-Through Concurrent and Countercurrent Operations, Using East Texas Gas Oil and 30 A.I. Clay Catalyst

Run Number	2053-T	2055-T	2054-T
Flow	——Concurrent——		Counter-Current
Oil Inlet Temp., °F.	900	840	900
Catalyst Inlet Temp., °F.	1000	885	1000
Aver. Reactor Temp., °F.	905	850	850
10 lb. RVP Gasoline:			
Octane Number, CFR-M, clear	80.1	78.7	78.7
Octane Number, CFR-M, + 3 cc. TEL	87.5	87.3	87.1
Octane Number, CFR-R, clear	91.0	88.6	88.5
Octane Number, CFR-R, + 3 cc. TEL	97.8	95.4	94.4
Sulfur, Wt. %	0.053	0.057	0.061

NOTE: The information in this table was condensed from Table 3 of the original paper.

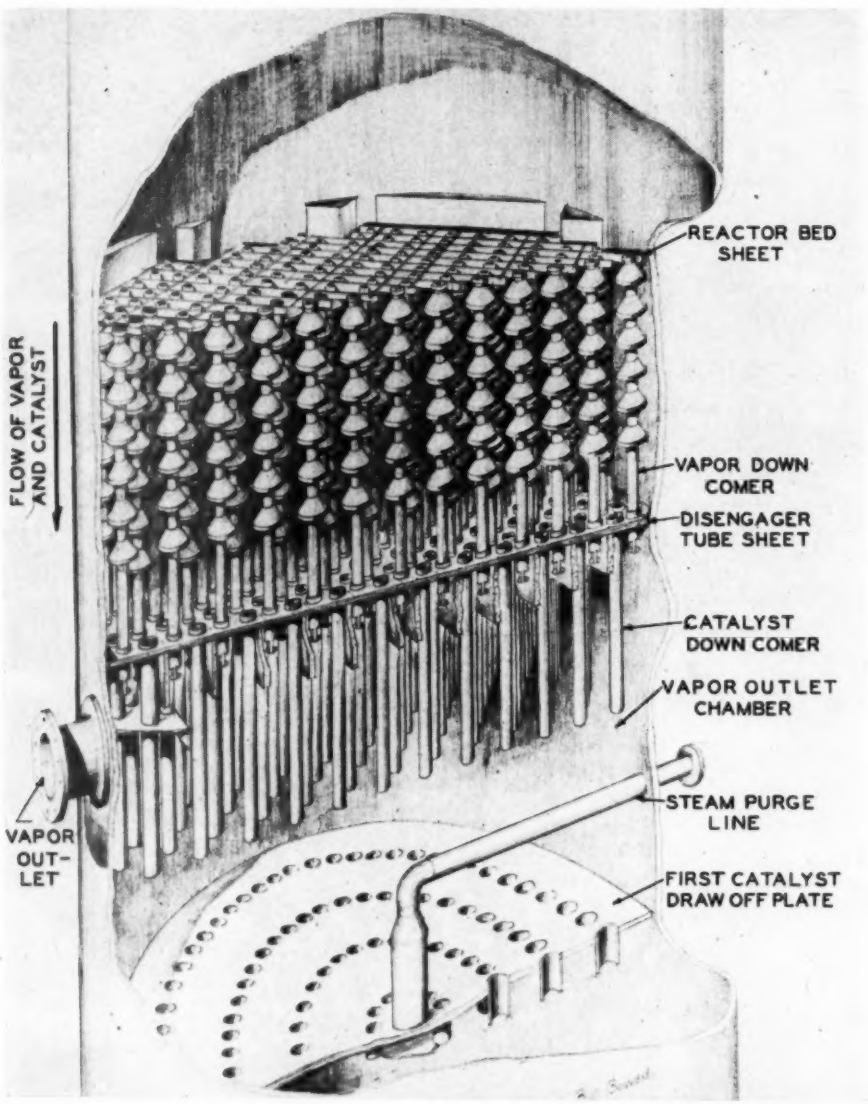

Fig. 2—Artists sketch of a typical oil-catalyst disengager

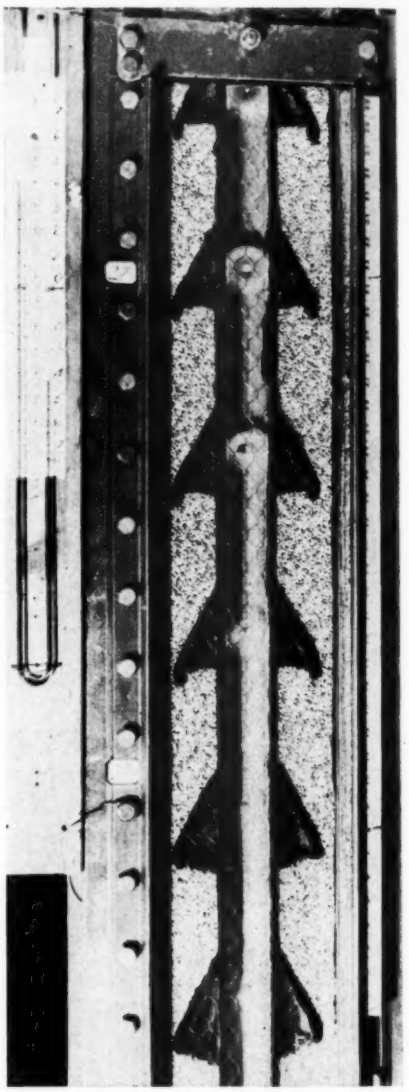

Fig. 3—Model disengager device

During the concurrent mixed phase tests the carbon concentration on the spent catalyst was relatively uniform, indicating that all of the catalyst was functioning with equal effectiveness. Concentrations varied as shown in Table 2.

Three pilot plant runs on an identical charge comparing the two types of flows showed that an average reactor temperature differential of about 50° F. was the result of concurrent flow for given oil and catalyst temperatures. This in turn produced a gasoline of slightly higher octane numbers as shown in Table 3.

Of the new devices installed, Houdry engineers believe that the two most significant are the catalyst-vapor disengager and the liquid injection nozzle. An artist's sketch of two typical disengager design is shown in Fig. 2, while Fig. 3 is a photograph of a model disengager device in operation.

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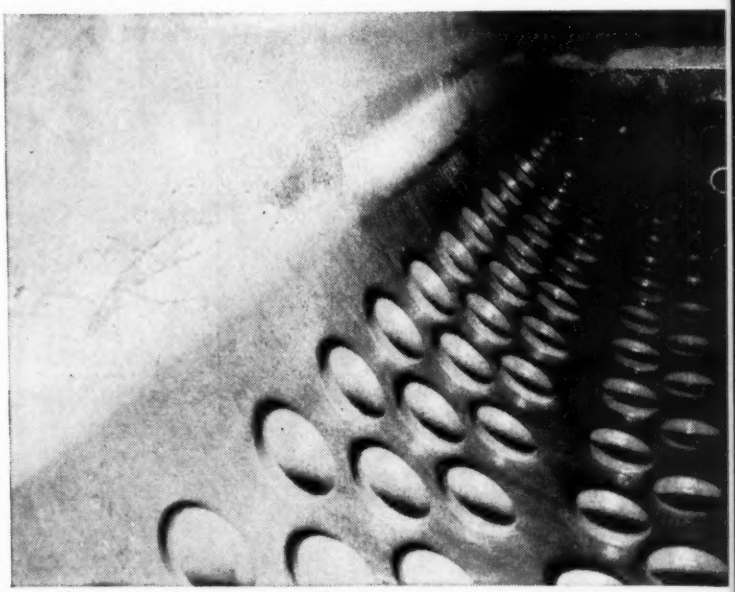

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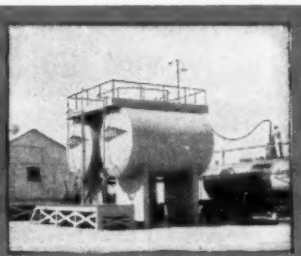

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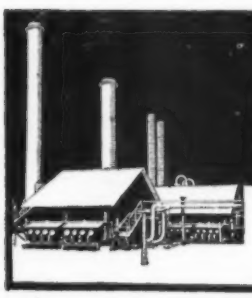

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reactor bed down through the space between the tubes with the inverted cones. Here the vapors pass up under the lips of the cones, into the ports of the vapor downcomers, and to a vapor outlet chamber bounded on the top by a disengager tube sheet and on the bottom by a level of catalyst on the first catalyst draw-off plate of the reactor. The vapor stream then flows to the synthetic crude tower.

Catalyst, also flowing down through the reactor, passes on to the disengager tube sheet, from which it is conducted through catalyst downcomer pipes to the first draw-off plate.

Vapors Removed at Successive Levels

Sufficient free area of the horizontal cross section of the disengager must be provided for a normal downflow of catalyst. In the Paulsboro unit the nominal rate was 100 tons/hr. At the same time, if all the vapor were removed at the first level of outlet ports, vapor velocities would be so high that catalyst particles would be carried out of the reactor and into the distillation equipment. It is therefore necessary to remove vapors at successive levels of outlet ports. As the volume of vapors increases, more levels of ports must be provided.

It can be clearly seen in Fig. 3 that at the separation point, catalyst and vapor are actually flowing countercurrently. The vertical spacing of disengaging levels is determined by the height required for uniform catalyst flow. It has also been found that staggering the draw-off ports on successive rows of vertical vapor tubes greatly improves catalyst flow.

Steam purging is done in the conventional manner. The commercial runs on non-vaporized stocks at Paulsboro were made with a catalyst residence time in the purge zone only 65% as great as normally required on vapor phase operations with no difficulty in purging and at the same rate of injection of purge steam.

Injection Nozzle

The pressure atomizing nozzle used to inject the non-vaporizable portion of the charge was located approximately as shown in Fig. 1. It was a conventional type nozzle with a 90° impingement of paired liquid streams; it had a capacity of 75 GPM hot volume and operated at about 100 psig. Inserted through the side wall of the reactor with a stuffing gland arrangement, it could be removed for inspection or for changing to straight vapor phase operation without shutting down the reactor.

It was designed to project a fog of atomized liquid onto the falling annular curtain of catalyst, thus utilizing the heat content of the central catalyst inlet stream before entering the reactor bed proper. The actual elevation of the fog nozzle above the top level of the bed was about 6 ft. However, the precise elevation is a function of the particular design of nozzle employed. In all cases the aim is to have the atomized liquid impinge on the catalyst curtain just above the bed.

INSTRUMENTATION for TOMORROW

Digests are given of some of the more important papers of interest to refiners presented at the First National Instrument Conference and Exhibit, Pittsburgh, Sept. 16-20. Also brief reviews of some of the new instruments and allied control equipment demonstrated, many for the first time

LATEST developments in instrumentation and automatic control, many of them wartime-born, were revealed at the First National Instrument Conference and Exhibit, held in Pittsburgh, Sept. 16-20.

A large number of the papers were either by oil company engineers or discussed refinery instrument installations, thus reflecting the extent to which refinery processing today is dependent on automatic controls.

Sponsored by the Instrument Society of America, the conference was built around the keynote, "Instrumentation for Tomorrow." It was planned "to stimulate the greater use of instruments for increased production and reduced costs." Attendance was reported to be about 4000.

Meeting jointly with the Instrument Society at the conference was the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers. The two groups held 18 technical sessions and presented 45 technical papers. Condensations of some of those papers of great interest to the members of the petroleum industry are presented below.

Of even more interest in some cases than the technical sessions were the many equipment exhibits and displays sponsored by nearly 100 manufacturers of instruments and allied products. These included practically everything in the instrument line, from simple mercury thermometers to the latest electronic recorder-controllers. Reviews of some of the newer items that have refinery applications follow the digests of the conference papers.

Commenting on the value of the meetings and exhibit, A. F. Sperry, president of the Instrument Society of America, stated, "The 'Instrumentation for Tomorrow' conference was more than a mere exhibit or convention. It was the coming of age of the Instrument Man, and the final recognition of his special significance in the world of science and technology. Our foremost economists forecast that instruments will shape the world of tomorrow. The Instrument Man has not only an opportunity but a responsibility to do his part."

Arrangements are now being made, according to Richard Rimbach, executive secretary of the society, for the Second National Instrument Conference and Exhibit, to be held the week of Sept. 8, 1947, at the Hotel Stevens in Chicago.

'Tuning Up' Refinery Instrumentation Avoids Later Operating Troubles

Digest of a paper "Process Unit Control Instruments, Their Installation and Initial Operation", presented at the First National Instrument Conference, Pittsburgh, Pa., Sept. 16-20, 1946 by Harry F. Moore, Esso Engineering Dept., Standard Oil Development Co.

UNLESS proper attention is paid the installation of process unit instrumentation, the refiner would be better off not to buy it at all. Too frequently measurement and control equipment is merely bolted into place, connected to the unit with pipes, tubes and wires, and then considered "ready for operation."

As a result, operators have reduced confidence in measurement and control devices, many controllers are by-passed or manually operated, and units are delayed weeks in making specification product.

The solution to these ills lies in giving this type of equipment proper "prenatal" care, with a definite group of trained instrument men assigned to check and calibrate all instruments and controls on a new unit, bridging the gap between construction and operation. Such specialized attention has been directed at instrumentation in the past in too few instances, by either the contractor or the refiner.

Construction Practices, Heavy Items

Building a large unit such as a catalytic cracker is heavy construction, and the primary concern of the construction crew centers on "tonnage items"—heavy foundations, tall towers, miles of piping and large furnaces.

In building these items the contractor utilizes the established trades of carpenter, mason, pipe-fitter, boilermaker, machinist, electrician and welder. The percentage of completion is usually measurable in tons, feet, or some similar unit, and is quite apparent when one looks at the job. When the concrete or pipe is in place it is "ready for operation."

With equipment, there is a different tempo. Centrifugal pumps are set on their foundations, grouted in, and then the machinists take over for lining up pump and driver, checking lubrication and packing, and a short trial run. Here the need for a greater degree of skill and attention is obvious and no one suggests eliminating the servicing or replacing the machinist with a less skilled person.

With gas engine driven compressors, turbo-generators and turbo-blowers standard practice is to have the manufacturer furnish a qualified man for erecting the equipment and preparing it for service, and to be present during initial operation. This procedure is easy for the construction man to understand and justify. It protects the manufacturer by preventing mistakes which a general machinist might make because of lack of specialized knowledge. It protects the contractor and refiner from the possibility of one small error causing the entire unit to be out of service beyond a normal construction time.

Installation of Instruments

When measurement and control instruments and equipment are installed one would expect they would be given special attention. Although not delicate they are certainly not as rugged as a heat exchanger or pump, and their functioning is quite mysterious to the layman. But there is no recognized craft to tend their individual needs. They are not large enough, expensive enough, nor individually important enough to the

operation of the unit to have the compressor or turbo-generator type of care lavished on them.

They are connected to process equipment and process lines with ½-in. and ¾-in. pipe, and to each other and control valves with miles of ½-in. or ⅜-in. tubing. Quite naturally, a pipe-fitter is assigned the job; and, as process lines are "installed" and "ready to operate" when they are connected together and fastened to supports, the pipe-fitter's job is considered finished when the instrument items are mounted and piping and tubing connected. The electrician runs the necessary wiring, and then, as far as the builder can see, the process control equipment is ready for operation.

The construction industry methods outlined above usually give satisfactory results for "tonnage items" and for exchangers, pumps, compressors and turboblowers. With process control instrumentation, because of the lack of proper personnel, the system fails and the construction industry does not yet clearly understand why.

The essential needs of proper installation and preparation for service of the measuring and control devices are so fundamentally different and so abstract to a "tonnage" man that it is commonly impossible to explain to his satisfaction why anyone other than the pipe-fitter and electrician is needed.

An Example of Satisfactory Service

On a recently constructed unit that had the measurement and control equipment properly handled by qualified instrument technicians and mechanics, a record was kept of the time spent by these instrument men. In addition to that spent by the builder's pipe-fitters and electricians, 5300 man-hours were necessary to bridge the gap between "construction" and "operation." A review of the work involved should dissipate the vague, intangible character that such activities have in the minds of construction people.

Table 1 was prepared from the time record referred to. In making the division between shop and field, time was listed in the shop column when the job was performed by shop-assigned personnel, whether the work actually took place in shop or in field. Thus, some items show only shop time when appreciable time was spent in the field, and vice versa.

When a breakdown of Item 1 is examined, the necessity of having someone other than a pipe-fitter and electrician on the job is obvious. The pipe-fitter could remove a flowmeter for overhaul, but who would tell him it needs overhauling. When it comes to checking and calibrating, it is not obvious to many why a manometer or transmitter needs to be field-checked when it has been certified at the factory. The answer is that it cannot be depended on to stand the jolting of a freight car, the many handlings of LCL freight, and the usual rough treatment of a construction job and still be within industrial tolerance limits. Modern equipment has adjustments for field recalibration. The need for someone who understands the equipment is obvious, and the ugly suspicion may even be planted that something beyond a mechanics classification may be encountered.

Likewise with Item 2, experience has established that pneumatic transmission system receivers require a check and calibration. Item 3 covers the inspection, repair and alteration of orifices. An instrument mechanic may or may not know that differences in the sharp edge of an orifice not visible to the eye can cause errors of ½ to 1%, but in any event he will not string a batch of plates over a pipe and have his helpers jauntily march off with the pipe on their shoulders.

The field time charged to Item 4 is accounted for by one job order: "Check and Adjust Control Valves", and included correcting stuffing box friction, setting plug travel and adjusting spring range. The shop portion covered alterations or repairs to three valves. It could be argued that a machine shop can perform any function necessary to make most control valve repairs. This is true, but only after someone who understands the operation of the valve points out specifically what must be done, and to what tolerances.

The time charged for level instrument in Item 5 was for responsiveness and rough calibration check, mercury filling to set the operating range within the suppression limits, and setting and adjusting signal switches. To perform some of these operations requires that classic tool of the instrument shop, the water column. Construction pipe-fitters wouldn't have such an item in the first place, and wouldn't know what it was for if one was offered for use.

Pyrometric Equipment

Item 6 covers activities for pyrometric equipment, both instruments and thermocouples. The approximately 200 thermocouples consumed most of the field time. Couples must be bottomed on the well or responsiveness and accuracy of measurement will be impaired. Wells must be of correct length to insure sufficient immersion for the high temperature measurements involved (950 to 1100° F.). And, although it sounds a bit silly, couples should not be connected to the lead wire with polarity reversed.

Items 7, 8 and 10 illustrate the need for personnel with qualifications beyond those of first class instrument men. A technician would be a minimum need, and an instrument engineer would be kept busy. The major portion of time charged to Item 7 was spent revising the air piping of four controllers so that a transfer of control from remote manual to automatic could be made without measurably changing the air output pressure. Such an arrangement is common place today, but two years ago such jobs were engineered in the field.

There's One on Every Job

Item 8 should never have happened. But something comparable can take place on any large job, creating an urgent need for experienced help. The unit has six large valves operated by hydraulic pistons, in turn controlled by standard pneumatic controllers through a pneumatic-hydraulic piston positioner. The positioner was mounted and the follow-up linkage connected by construction mechanics. Sometime before instrument people checked and adjusted the positioners the pistons were operated through their full travel for a construction purpose. Shipping stops in the positioner has not been removed, travel limits were not set, and several roller style cam followers were off the cams. When the positioner covers were removed, the contents almost literally consisted of a bushel basket of bent, broken parts. With the unit scheduled to start operations in four days, speed of repairs was essential. Technicians, excellent shop facili-

TABLE 1—Time Required To Get Instrument Installations Ready for Operation

Item No.	Description	Man-hours — Shop	Man-hours — Field
(1)	Flow manometers—check, calibrate, repair, range tube changes, correlation	283	711
(2)	Pneumatic receivers—check, calibrate	11	153
(3)	Orifices—measurement and restriction. Inspect, repair, alter	52	30
(4)	Control valves—check, adjust, repair	62	423
(5)	Level instruments—check, calibrate	92	...
(6)	Pyrometers—check, calibrate. Couples—check installations	22	199
(7)	Controllers—alter, repair. Arrange by-pass panels	56	...
(8)	Piston positioners—repair construction damage, alter	102	...
(9)	Pressure gages—test, set	34	...
(10)	Boiler level alarms—design, build, install	77	...
(11)	Dial thermometers—survey for, install	...	17
(12)	Panel name plates—make, install	97	...
(13)	Emergency alarms and trips—final operation check	...	17
(14)	All instruments—final field correlation check	...	242
(15)	All instruments—final operating test	...	803
(16)	Office and engineering—inventory, records, instrument location and identification layouts, explanatory diagrams	1834	
	Total, Shop	888	
	Field		2595
	Office and Engineering	1834	
	Total	5317	

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ties and well qualified shop men being available solved the problem.

Item 10 became necessary when tests confirmed the suspicion that the level indicating and alarm equipment furnished for waste heat boilers was inoperable under prevailing conditions. This was during the war, when long delivery time for instruments was notorious, so the necessary equipment was made locally, using a few old instruments and a lot of ingenuity. This should clearly show necessary work between construction and operation cannot be met with a few hours free time by suppliers' representatives.

Pressure of Primary Importance

Pressure gages, Item 9, are cheap, and anyone can install them. But when the unit starts, pressures assume primary importance, and therefore require a check. Many will be found outside normal tolerance, which is understandable considering their low torque.

The dial thermometer installations, Item 11, were desired by the operators for convenience in setting certain hand adjusted valves, as on the exit water line from a cooler, to minimize water consumption.

Item 12, name plate fabrication and installation, is an example of a relatively unimportant item taking appreciable time. It is not properly a part of preparing the instrument equipment for service —but such misplaced items are not rare.

The importance of Item 13 is out of proportion to time recorded. The unit had an elaborate system of emergency instruments, and the malfunctioning of any portion of it would have serious consequences. Previous experience indicated a close check was essential because of the complicated circuits involved.

Item 14 was the final correlation check of all instruments against construction drawings and specifications, Such a check insures, for example, that a 50-in. manometer location has a 50-in. manometer installed in it, not a 100-in. manometer. Such a check brings to light an astounding number of mistakes. The sheer weight of numbers of instruments is usually to blame.

Full Scale Dress Rehearsal

The final operating test of all instruments, Item 15, is the full scale dress rehearsal, in which everything of an operational nature is checked that can be checked without the running process conditions, to detect malfunctioning of any individual piece of equipment. At this time proportional bands and reset rates are set at approximately correct values and the operation of control mechanisms is checked.

Item 16, last but not least with its 1834 man-hours, has a descriptive title —"Office and engineering—inventory, records, instrument location and identification layouts, explanatory diagrams." One of the jobs covered was the preparation of a comprehensive tabulation of all instruments. Advantage was taken of the detailed knowledge available during construction to prepare accounting records.

Summary and Conclusions

The builder might look at Table 1 and find many items which to him are not "construction". The operator and his instrument people would insist, however, that every item be taken care of before oil is pumped into the charging line. Both may be right. All too often, however, neither party takes care of them.

Table 1, even though some items are not clear cut, some overlap and some known to have been performed are not indicated, clearly illustrates the need for specialized personnel to perform specific tasks for the process control instrumentation prior to operation of the unit.

Thermowell Costs Can Be Reduced By Simple Design Principles

Digest of paper "The Design of Thermocouple and Thermometer Wells", presented at the First National Instrument Conference, Pittsburgh, Sept. 16-20, 1946, by George R. Feeley, Trinity Equipment & Supply Co.

SUBSTANTIAL reductions in the cost of thermowell requirements can be achieved by applying a few simple principles of thermowell design to eliminate unnecessary fabrication expense. In addition, selection of the right well for the job should bring about further savings by reducing failures and the subsequent high cost of frequent replacement.

Before discussing thermowell design, it should be made clear that this paper is not intended as a plea for thermowell standardization. Different applications and conditions unquestionably require different designs and materials.

The purpose is to point out how various types of wells are made and how industry can save by eliminating the many slight and unimportant variations in designs which frequently require substantial but unnecessary fabrication time.

Many special wells are needlessly expensive, having been designed without regard for the manufacturing problems involved. It is logical, therefore, that every instrument engineer should have a knowledge of the basic requirements of a good thermowell, the different types of wells, how they are made, and how to decide which will best suit particular requirements.

"Built-Up" Wells

There are two basic types of wells, "built-up" and "solid drilled." The built-up type, the simplest form, consists of a piece of pipe or tubing which usually has one end closed by welding or spinning, or both. In many installations, the well is welded into place.

Built-up wells are satisfactory in many instances and are widely used because of their low cost and ease of fabrication. Any machine shop with welding equipment can make them. Also they are available in almost unlimited length.

They have several disadvantages, however. They require material available in tubing form and standard sizes, particularly troublesome when using bulb type instruments as proper fit between bulb and well is essential. There are means of eliminating this objection, but proper fit is still the most favorable condition.

Another disadvantage is the possibility of failure as a result of welding, particularly in the chrome-nickel steels when unstabilized material is used and the finished well is not properly stress relieved. Carbide precipitation may result, in which case the material tends to lose its corrosion resistance. That this occurs at a point some distance from the welded joint is often misleading when investigating the cause of failure. Carbide precipitation takes place where the well has been held at 900-1600° F. during the welding operation. As the area being welded is about 2900° F., the trouble will develop at a point substantially away from the weld. Because it is very difficult to insure proper stress relieving, welded joints in themowells should be avoided whenever possible, particularly when severe service is encountered.

"Solid Drilled" Wells

"Solid drilled" wells are made by drilling bar stock, a forging or a casting to the proper diameter and depth, and then machining to the required outside size and shape. Although limited to wells 6 ft. long, they are best from the standpoint of safety, accuracy and flexibility of design.

Welding and heat treating are eliminated. Walls can be made as heavy or thin as the installation requires, and any machinable material can be used.

Many thermowell users have shied away from use of the solid drilled wells because they were unable to determine the concentricity of the hole, and consequently feared that the wall thickness might not be uniform. Recently, how-

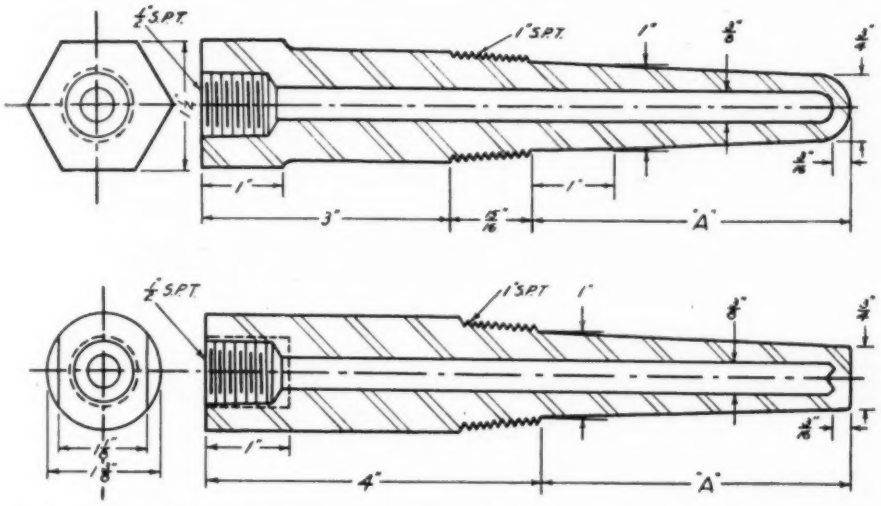

Fig. 1—Minor design changes which eliminate costly and unnecessary machining can often reduce thermowell costs by as much as 25% or more, as indicated by the two designs above. The lower design eliminates one of the two tapers below the thread, the round hole bottom and the round end, and uses round bar stock instead of hexagonal, all resulting in less machine work

ever, several devices have been developed to measure wall thicknesses accurately and all reputable well manufacturers have means of checking bore concentricity.

The question arises: How close should wall thickness be held, or, in other words, what is a good allowable tolerance? While it is possible to hold this to within .001 in., it is generally not practical; the outside machining takes too long. A practical allowable tolerance on bore concentricity is 10% of the wall thickness.

The use of solid drilled wells is recommended whenever possible. Often one can economize by making the critical part of the well out of solid bar and welding it to pipe or tubing for extension through heavy insulating walls or similar instances requiring a length of well not exposed to extreme service conditions. Built up wells are suitable for many services, but should be avoided wherever failure might cause a costly shut-down or serious injury to operating personnel.

Basic Design

There are three basic points to be considered in designing a thermowell:

(1.) Type of instrument with which it is to be used.

(2.) Type of equipment on which it it is to be installed.

(3.) Service under which it will be required to operate.

The type of instrument with which a well is to be used will determine one of the basic points of well design—internal diameter. Bulb type instruments require close fit between the inside of the well and the bulb, while thermocouples do not require a close tolerance on the bore.

The type of equipment into which the well is to be inserted will determine, in most cases, the means used to join the well to the equipment. There are four basic means of accomplishing this; taper pipe threads are the most common, but flanged, ground and welded joints are also used in many installations.

The type of service under which the well will operate—temperature, pressure, speed of flow, corrosion, erosion—must be considered to determine how sturdy the well must be, wall thickness and external shape.

Most thermowell designs leave the well length variable, so that the design can be used under varying conditions. It is of course, necessary that the well be of sufficient length to enable the temperature element to be inserted far enough into the process fluid to insure proper readings.

Minor but Costly Design Features

After the basic design has been determined, several questions will arise concerning points of lesser importance. Should the closed end be squared or round, should the portion below the joint be straight or tapered, what should be the shape of the bottom of the hole, what size threads would be best if a threaded joint is used.

These things usually have little effect on the proper operation of the instrument; however, they often have a great effect on cost. Fig. 1 shows two almost identical well designs, yet there is a difference in fabrication cost of more than 25%. As neither has any particular advantage from a service standpoint, it seems logical to eliminate this extra cost.

The upper drawing has several features which needlessly increase cost. Extra machining operations are required to shape the end of the well and the bottom of the hole. A close examination shows two tapers below the thread, one from the threads to a point 1 in. below, and the second from that point to the end. Two machine setups are necessary and a substantial amount of time is required to blend the two tapers and provide a smooth finish. The hexagonal material used increases the poundage of stock required. On short wells the use of round bar stock is not a saving as the cost of milling wrench flats tends to offset the difference in material cost, but it cuts the cost of longer wells, and tends to improve delivery, as rounds are generally more readily available than hexagons.

The lower drawing eliminates all these features. Round bar stock is used instead of hexagonal, the hole is left as drilled, the end is cut off square and the portion below the threads is cut on a single taper.

Other Design Considerations

Fig. 2 shows a well designed for use with a bimetal thermometer and is included to illustrate the advantage of solid drilled wells in eliminating unnecessary dead air space between sensitive element and socket wall. General practice on this type of well is to ream the hole .010 in. larger than the bulb and to hold its diameter to ± .001 in. This allows clearance to prevent binding and at the same time cuts the insulating effect of air space to a minimum. Holding this tolerance costs money and the hole is

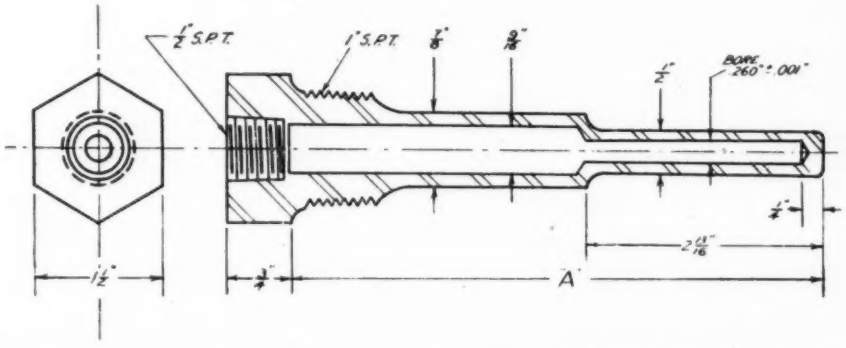

Fig. 2—Design of a solid drilled well for use with a bimetal thermometer. The hole is reamed .010 in. larger than the bulb, and held to ± .001 in. To facilitate machining, the hole is enlarged above the sensitive area

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enlarged above the sensitive area to facilitate machine work.

Fig. 3 shows a simple design of general purpose well. Machining is cut to a minimum, and below the threads the well is straight, avoiding costly tapering.

Fig. 4 shows various types of joints used in well design. "A" is the threaded joint most commonly used. Many wells, however, must be removed at frequent intervals for inspection. Use of a flanged joint is recommended in such cases, as threads tend to distort under repeated tightening. The most common type, "B" is made by drilling a blind flange to fit the well and then welding the two as shown. If welding is not advisable, the Van Stone flange, "C", can be used.

On severe service, it is often necessary to eliminate gaskets and use ground joints. Type "D" and "E", ground on a radius, are called ball joints. Well "F" has a tapered ground joint which is seldom used because of the expense. Ground joint wells are usually no more expensive than threaded wells; however, their installation is costly because of the rather elaborate fitting into which they must be inserted.

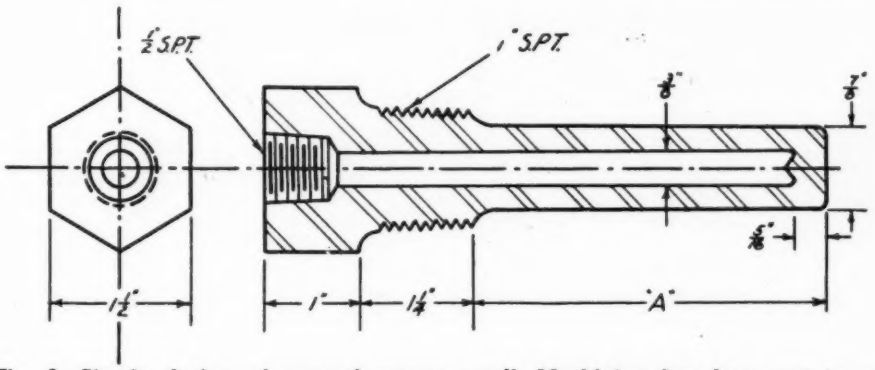


Fig. 3—Simple design of general purpose well. Machining has been cut to a minimum, with no costly taper below the threads

Good Air Supply System Essential For Successful Pneumatic Control

Digest of a paper "Design of Instrument Air Supply System for the Process Industry", presented at the First National Instrument Conference, Pittsburgh, Sept. 16-20, 1946, by W. C. Ludi, Esso Engining Dept., Standard Oil Development Co.

MOST refinery instrument air supply systems do not meet all the requirements necessary for the successful operation of pneumatic controls. As a result, both the morale of the operating crew and confidence in the ability of the control instruments are lessened.

There are three fundamental requirements for an instrument air supply—reliability and constant pressure, cleanliness, and dryness.

Reliability, Pressure—The supply at all times should be reliable and at a constant pressure, otherwise many instrument failures will occur because of the lack of actuating air. Failure of the air for only a short time can cause a unit to be upset much longer. To meet the reliability requirement, it is desirable to have auxiliary equipment cut in automatically when either partial or total failure of the normal supply occurs.

Cleanliness — For all practical purposes, there are two types of contaminating materials which must be removed and kept out of the air system—solid matter (dust, dirt, scale) and oil. Solid matter can plug nozzles, restrictions and pilot valves, resulting in complete controller failure. Oil often deoxidizes and gums up the moving parts, resulting in erratic and unsatisfactory controller action.

Dryness — Moisture is present in all compressed air and will be a constant source of trouble when not adequately removed. Some of its chief effects, all of which cause unreliable instrument performance and interruption of service, follow:

(a) Freezing of the water where low temperature is encountered, causing loss of air to a single control mechanism, a group of mechanisms or an entire area.

(b) Corrosion of piping and connections, causing rust scale, dirt and dust.

(c) Emulsification of water vapor and any entrained oil in the air, resulting in fouling of the control mechanism.

In most large plants the general yard air system at first glance appears to be a good source of supply. The air is usually available throughout the entire plant at reasonable pressures and at all hours, and might be assumed, therefore, to meet all the requirements.

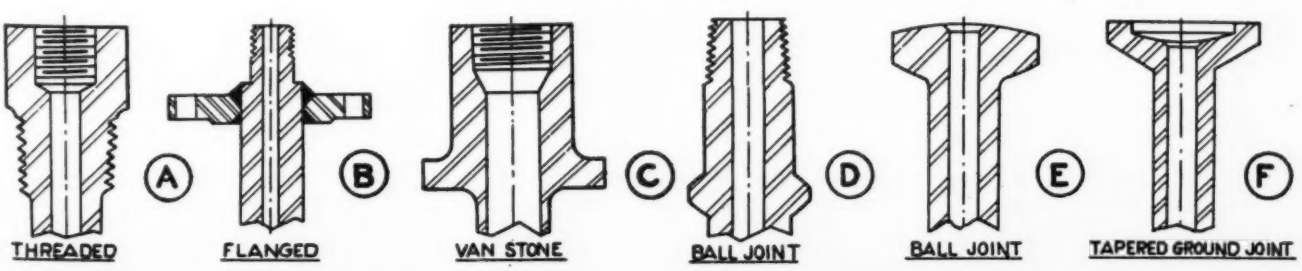
The yard system, however, is used for many purposes which frequently make heavy demands, such as blowing out lines, operating air tools, or pressure testing lines and vessels. If two or three of these operations are performed simultaneously, the supply pressure may drop from a normal 100 psig to 20 psig throughout the entire system, far below the satisfactory level for instrument operation.

In another instance where the general yard system was being used, it was necessary to blow out a caustic line. Pressure in the caustic line was higher than in the air line, and when the air valve was opened caustic backed into the air distribution system and was carried into the instruments, causing severe corrosion and complete controller failure. Check valves provided to prevent backflow did not hold.

Types of Instrument Air Systems

Following are four types of air systems which may be used to supply in-

Fig. 4—Various types of joints used in thermowell design. Threaded joints (A) are most commonly used, although flanged joints (B and C) are recommended when the wells must be removed periodically for inspection. Ground joints (D, E, and F) are used when gaskets must be eliminated



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strument air, and which meet the principal requirements:

(1) A central system for instrument actuation only, requiring a compressor and necessary standby equipment, aftercooler, separator, receiver, drier, and distribution system.

(2) Using the general yard air compressors when reliable, but giving instruments preference over all other users. Instrument air for this system is taken at the air receivers before it enters the general yard air distribution system. This requires control equipment at the receiver to insure preference for the instrument system, an aftercooler (if none is used between the compressors and air receiver), separator, drier and distribution system.

(3) Using the general yard air compressors and distribution system, when reliable, but installing auxiliary equipment within each process unit or area to cut in automatically when the yard pressure drops below safe operating pressure. Also required at each take-off from the yard system are an aftercooler, separator, receiver and drier.

(4) Individual air systems at each process unit or area. These require equipment essentially the same as described under Item 1, but on a much smaller scale. This system has the drawback that when small compressors and auxiliaries are used, it is difficult to obtain machines to give long life and minimum carryover of oil.

Many other systems can be devised, but these four cover the main variations. It is believed that the isolated system complete within itself (Item 1) insures the best compressed air for instrument actuation and allows control equipment to operate free of actuating medium problems.

Designing the System

Before a central air system for instruments can be designed, the following information is required: (a) Pressure desired at the process areas, (b) air requirements in scfm (standard cubic feet per minute) and (c) maximum and minimum atmospheric and cooling water temperatures.

Pressure Requirements — Most instruments require air at approximately 20 psig. Allowing 5 lbs. for pressure drop through a reducing valve preceding the instrument, 10 lbs. for flexibility in the system and 10 lbs. for pressure drop through the drier and distribution system, approximately 45 psig are required at the central systetm.

Instrument Air Consumption — Air consumed by an instrument is a much discussed point and one on which widely varying figures are quoted. In one plant in which the majority of instruments had non-bleed pilots, normal consumption was 0.35 scfm per pilot, and maximum consumption 0.47 scfm per pilot. In another plant in which all instruments had

bleed pilots, air was consumed at a constant rate of 0.46 scfm per pilot. When non-bleed pilots are used, the air rate varies considerably, but the maximum air requirement must be available during an upset condition, and therefore it is necessary to design for this condition. A review of these data indicates that 0.5 scfm per pilot is a good figure to use as the rate of consumption of each consumer, regardless of pilot type. The total number of pilots on all air-actuated controllers, therefore, determines what the air requirements will be. In a plant having 600 pilots, air requirement would be 300 scfm. To this figure a factor of at least 15 to 20% must be added to take care of leaks, blowdown and future instrument additions.

Temperatures Encountered — In order to avoid deposition of moisture in the air supply system, the air should be dried to a dew point of from 5 to 10° F. below the ambient temperatures before it enters the distribution system.

Equipment Required

Fig. 5 shows the layout for all the pertinent equipment required for an isolated instrument air actuation system, including compressors, aftercooler, separator, receiver and drier. The following specific comments on equipment choices are given for an assumed installation in which the system has been designed to supply air to eight different process areas containing a total of 364 control instruments. Since the total number of pilots on these instruments is 534, the total air required is 267 scfm; adding 15% for leaks and future instruments, boosts the air requirement to 307 scfm. The system was designed for 310 scfm, to be supplied at 45-55 psig. Maximum and minimum ambient temperatures encountered are 95 to 50° F. summer conditions, and 0° F. minimum in winter. Cooling water temperatures vary from 35 to 75° F.

Compressors — Two air compressors should be provided, each having a minimum actual free air capacity of 310 scfm at 45-55 psig discharge pressure. If steam and power balance permits, one compressor should be motor driven for normal operation and the other steam turbine driven for standby service. These machines should be the heavy-duty continuous service, slow speed type, which has been shown to give minimum maintenance and maximum trouble-free service.

Cylinders should have forced feed lubrication with means of adjusting the rate at which lubricating oil will be fed. Splash lubrication of the cylinders should be avoided in order to keep the oil entrainment in the air to a minimum. The suction side of the compressors should be provided with a dry type filter for removing atmospheric dust and dirt. A pressure unloading system should be provided to maintain the output pressure between 45 and 55 psig.

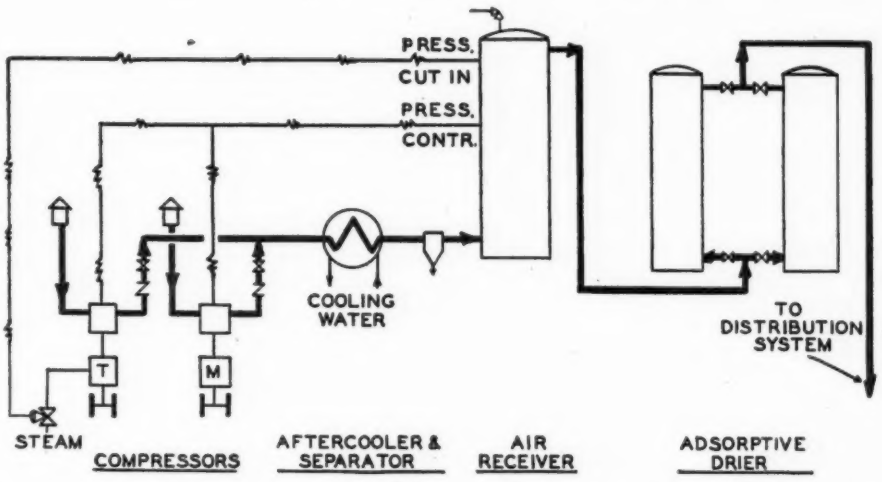

Fig. 5—Schematic flow diagram for an isolated instrument air supply system. Two compressors are provided—one motor driven for normal operation, and one steam turbine driven for standby use. Pressure controls on the receiver are set to maintain output pressure at 45-55 psig, and to cut in the standby equipment whenever the pressure falls below 40 psig. The two absorptive type driers are used alternately, one being regenerated while the other is on stream

The standby compressor should be arranged to start automatically whenever the discharge pressure drops below 40 psig. The turbine governor of the steam driver should be suitable to control the speed of the turbine under all normal operating conditions in order to eliminate any possibility of having the emergency overspeed trip shut down the turbine when the compressor unloads.

The compressor suction should be located at a point outside the building, to keep air contamination due to local conditions at a minimum.

Aftercooler, Separator, Receiver — To cool the air and remove as much moisture and oil as possible by simple means, an aftercooler (with integral separator) and a receiver should be provided at the discharge of the compressors, arranged to serve either compressor. An automatic condensate trap should be supplied to eliminate separated moisture and oil from the aftercooler and receiver. The aftercoolers are normally sized to cool the air to within 15° F. of the inlet water temperature. The air receiver is normally sized to have a capacity equal to the compressor output for at least one to one and a half minutes operation. For 310 scfm output at 45-55 psig, the receiver should have a volume of 67-100 cu. ft.

Driers — Two principal methods of moisture removal may be used, cooling or absorptive drying.

Cooling alone can be used where it is possible to cool the air 10° F. or more below ambient without having the cooling medium below 35°F. When cooling is the only means of drying, it should be done before the receiver. Even when absorptive drying is used, the aftercooler is in effect a partial drier and serves to reduce the load on any subsequent drier.

In the case under discussion, ambient temperatures are such that the cooling method alone cannot be used, so that an absorptive drier must be added. It should be designed for the capacity of one compressor with air entering at 55 psig, saturated with water vapor at 90° F. for the summer condition and at 50° F. for the winter condition. It should be capable of maintaining a dew point at the outlet of 40° F. for summer conditions and —10° for winter conditions. The unit should be the dual tower type, water cooled, and designed for semi-automatic operation on an 8-hr. drying cycle using either steam or electric reactivation.

Such a separate instrument air system as described above, when properly designed, provides clean, dry air at a constant pressure and in adequate amounts. It insures continuous and uninterrupted operation of all process equipment, and reduces instrument difficulties to a minimum.

For brief descriptions of some of the newer control equipment and instruments exhibited at the National Instrument Show see the following page . . . . . ➡

New Instruments and Control Equipment

Below are presented descriptions of some of the instrument and allied control equipment shown and demonstrated, much of it for the first time, at the recent National Instrument Conference and Exhibit at Pittsburgh, Sept. 16-20. Although this section is not intended to represent complete coverage of the exhibit, the editors of PETROLEUM PROCESSING have attempted to include all items recently put on the market or of especial interest to refiners.

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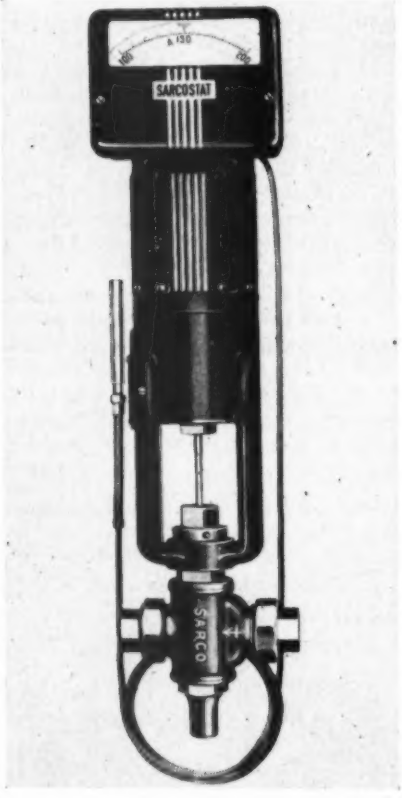
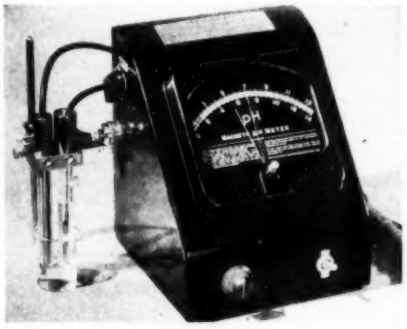
Electric Controller. . .

Based on a new hydraulically operated electric motor valve which is available both for open and shut type control with remote thermostats and as a fully throttling temperature regulator (illustrated). On the latter instrument, the indicator and temperature setting device can be directly attached to the valve or arranged remote from it. Sarco Co., Inc., 475 Fifth Ave., New York 17.



pH Meter. . .

Direct line-operated, continuously indicating from 0 to 14 pH. Uses no batteries, can be connected to 115-volt line, 50 or 60 cycles (220-volts, AC, 50 to 60 cycles also available). Equipped with voltage regulator, compensating for fluctuations between 105 and 130 volts. Frequency variations do not affect it. Accuracy of 0.1 pH, and sensitivity of 0.05 pH. Includes plug to accommodate the calomel electrode lead of standard high resistance now in general use. Can be used in temperatures up to 50° C. Macbeth Corp., 227 West 17th St., New York 11.



X-Ray Photometer. . .

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Oxygen Indicator. . .

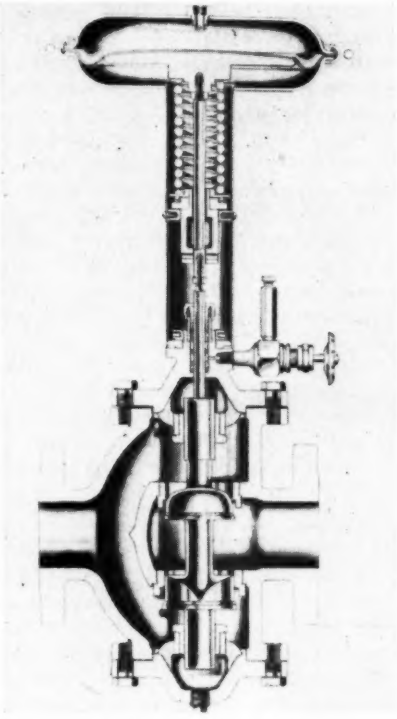
For checking for the presence of oxygen in hydroforming, in purged atmospheres for catalytic cracking, or anywhere that oxygen is a contaminant or a corrosion hazard. Available with four alternate scales from 0 to 0.5% to 0 to 0.25%, sensitivity of one part in 10,000. Uses an electrolytic detector cell, offers continuous operation, simple maintenance, optional continuous recording; alarm sounding or control circuit operation is optional. 13½ in. high, 17¼ in. wide, 10 in. deep, weighs 40 lbs. Requires sample flow of only 25 to 75 cc./min. Contained in metal case for either surface or flush panel mounting. Mine Safety Appliances Co., Braddock, Thomas, and Meade St., Pittsburgh 8, Pa.

Air Relay. . .

Non-bleed, proportioning quick-response type, designed to increase sensitivity of air-operated controls and reduce volume of air drawn from compressor to a minimum. Slightest change of controlled element brings an immediate proportionate response of the diaphragm valve from the control instrument. Gotham Instrument Co., Inc., 149 Wooster St., New York 12.

Diaphragm Motor Valve. . .

A complete line for pressure regulators, pump governors, and diaphragm motor control valves. All steel diaphragm motor construction. Diaphragm casings are boltless, assembled with quick acting clamp rings. Diaphragms are reinforced neoprene. For extremely high or low temperatures, finned radiated bonnets are available. Valve bodies in bronze, semi steel, cast steel, forged steel, and special alloys, in sizes ½ to 16 in. Kieley & Mueller, Inc., 2029 43rd St., North Bergen, N. J.



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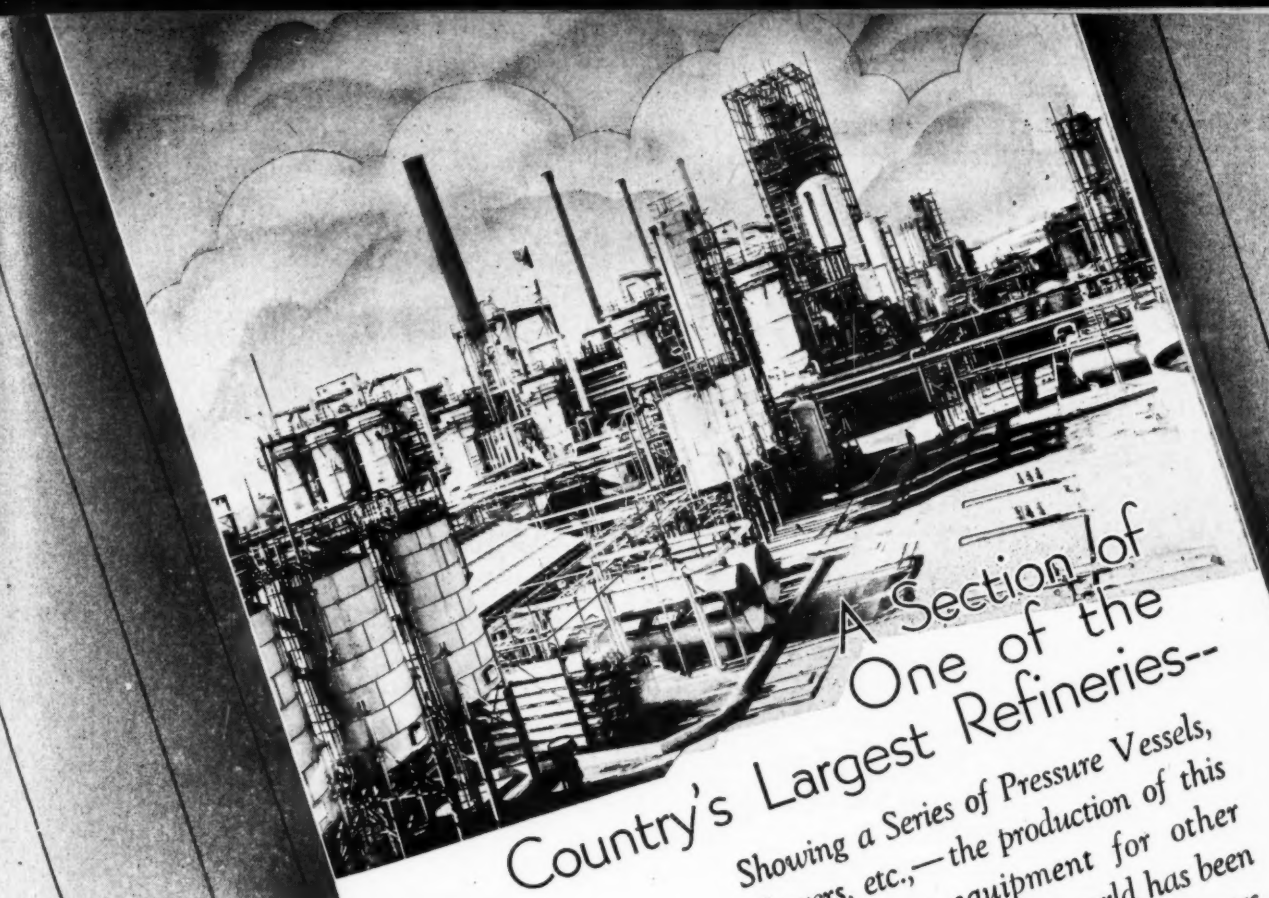

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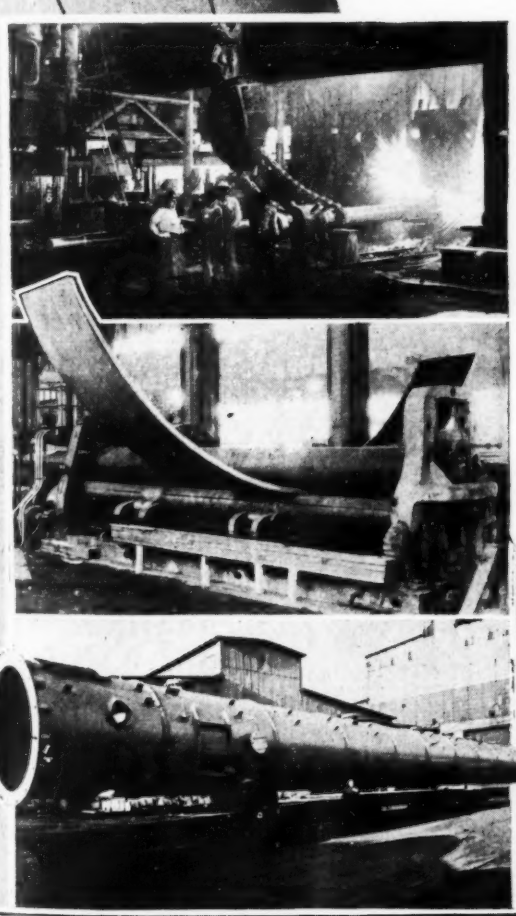

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Examples of calculations are given for various types of ethanol-water mixtures: 50% ethanol, balance water; and 35% ethanol, balance water. This second in a series by Dr. White extends the discussion begun in last month's *Petroleum Processing* on the application of the fundamentals of vapor-liquid equilibria and of enthalpy-composition diagrams to the calculations of the operation of several equilibrium stages.

By ROBERT R. WHITE

Associate Professor, Department of Chemical and Metallurgical Engineering, University of Michigan

Stripping Columns

WHEN a plate column is used to remove the more volatile component from a liquid feed the operation is known as stripping and the column is known as a stripping column. Since a vapor stream must be supplied to the column in order to accomplish the desired fractionation, the most convenient procedure is to generate the stripping medium from the liquid leaving the bottom plate by the use of a still as shown in Fig. 1 instead of obtaining it from an independent source as when using open steam.

The liquid overflowing from the bottom plate of the column passes into the still where heat is supplied. The vapors generated from the still pass upward to the bottom plate. The desired stripped product B is withdrawn from the still liquid or in some cases from the still vapor or the liquid from the bottom plate. The feed F is introduced on the top plate and a distillate product V_1 is withdrawn from the top plate.

The calculation of the number of equilibrium plates required in a stripping column is shown in Fig. 1, which is the solution to the following example:

Example 1.

The ethanol content of a feed containing 50.0%-wt ethanol, balance water, is to be stripped in a plate column equipped with a still to produce a bottom product containing 1.0%-wt. ethanol. Heat is to be supplied to the still at the rate of 440 BTU/lb. of feed. The feed, at 70° F., is introduced on the top plate and the overhead vapors are condensed to give a distillate product. The column is to operate at 1 atm. pressure. The bottom product is withdrawn as a liquid from the still.

Compute:

(a) The number of equilibrium plates required.

(b) The quantity of distillate product per pound of feed.

The feed is represented in Fig. 1 by the point F and the bottom product by the point B on the liquid saturation line. The point O represents the feed plus the energy added to the sys-

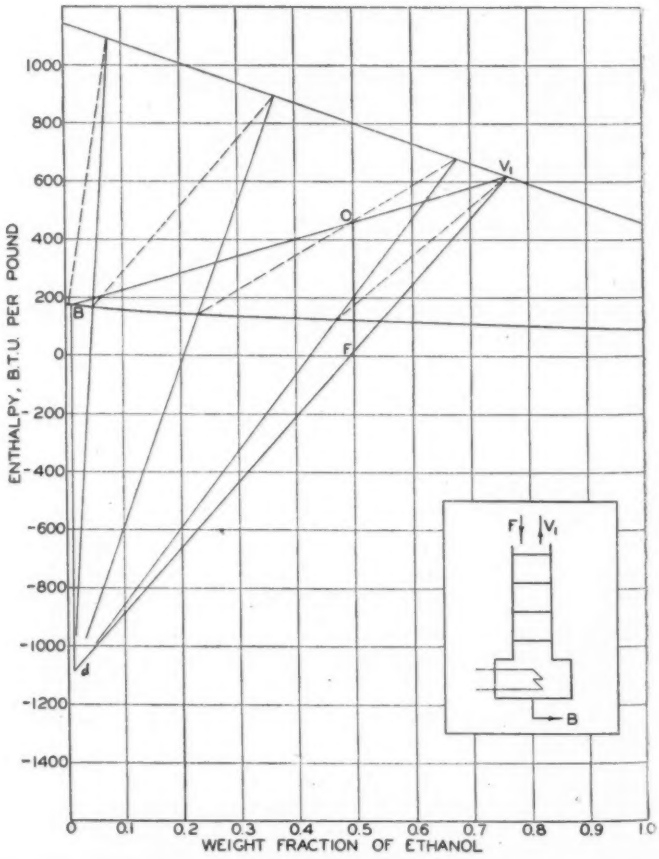
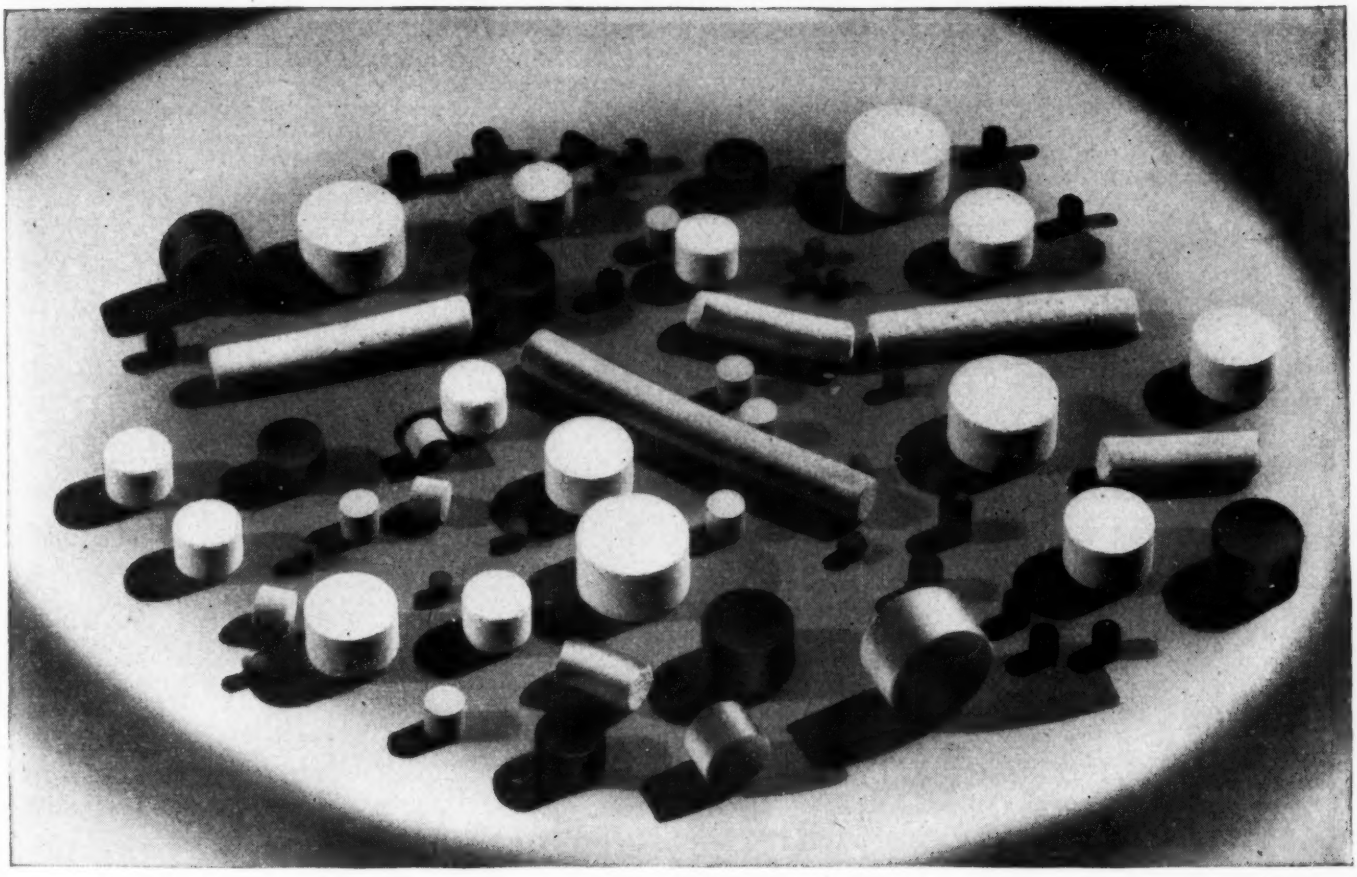


Fig. 1—Enthalpy composition diagram for a stripping column. Simplified sketch of stripping column is shown in inset



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tem in the still, the distance OF being equal to 440 BTU/lb. of feed. The point O also represents the sum of the bottom product and the overhead distillate vapor V_1, and therefore the point V_1 is located by extending the line BO to the vapor saturation line.

The stripping column shown in Fig. 1 is equivalent to the continuous process of Fig. 2b of the first paper of this series, in which energy is added to the system in the still. The vapor product V_1 rising from the top plate leaves the system and corresponds to stream A of Fig. 2b of the previous article. The feed stream entering the system corresponds to the stream C; the bottom product withdrawn from the still minus the heat added in the still corresponds to the stream B minus the energy added to the system per pound of stream B. Since the feed stream F, entering the column equals the sum of the distillate product V_1, and the bottom product minus the energy added in the still, d (x_B, $H_B - Q_B$), the points F, V_1, and d define a straight line on an enthalpy composition diagram. The point d is located in Fig. 1 by extending the line V_1F to the value, $X_B = 0.01$.

The point d also represents the difference between the feed entering the top plate and the distillate product leaving the top plate and therefore the difference between the liquid and vapor passing one another between any two plates of the column. The plate to plate construction is now carried out as described previously and the number of equilibrium plates required is determined as 3.8. The vapors leaving the still may usually be assumed to be in equilibrium with the liquid in the still and therefore the number of equilibrium plates which must be provided in the column equals $3.8 - 1.0 = 2.8$. The quantity of distillate product per pound of feed is equal to the ratio of the distances $Fd/dV_1 = 0.782$.

The above example indicates that a stripping column is of value chiefly for reducing the concentration of the more volatile component in the bottom product whether or not a still is employed. The distillate product must, of necessity, have a composition close to that of the feed composition, since these vapors arise from the plate to which the feed is introduced. It should be pointed out, however, that the feed plate liquid composition is not equal to the feed composition as shown in Fig. 1 where the feed composition is 0.500 and the feed plate liquid composition is 0.476 weight fraction of ethanol.

Rectifying Columns

When a plate column is used to remove the less volatile component from a vapor feed, the operation is known as rectification and the column is called a rectifying column.

Consider the case where it is desired to increase the concentration of ethanol by removing water from a vapor mixture of ethanol and water (such as V_1 of Fig. 1). Since the composition of the distillate vapor product from the column is largely dependent upon the composition of the liquid supplied to the top plate, a low concentration of water or any other undesirable component is required in the liquid feed, R, supplied to the top plate of the rectifying column.

If such liquid feed is available it may be supplied from an independent source. It is not necessary and it is usually impossible to obtain such liquids from independent sources. They can be obtained readily by condensing and returning a portion of the overhead vapors to the top plate. Liquid so returned is called reflux. A diagrammatic illustration of a rectifying column equipped with a condenser, receiver and reflux pump to furnish reflux is shown in Fig. 2.

The overhead vapors V_1 from the top plate pass through the condenser where the vapors are condensed. The condensate is collected in the receiver and divided into two parts; one constituting the reflux R which is pumped back to the top plate and the other constituting the distillate product D. In this way a liquid reflux is obtained which is substantially free of undesirable components.

The calculation of the number of equilibrium plates required

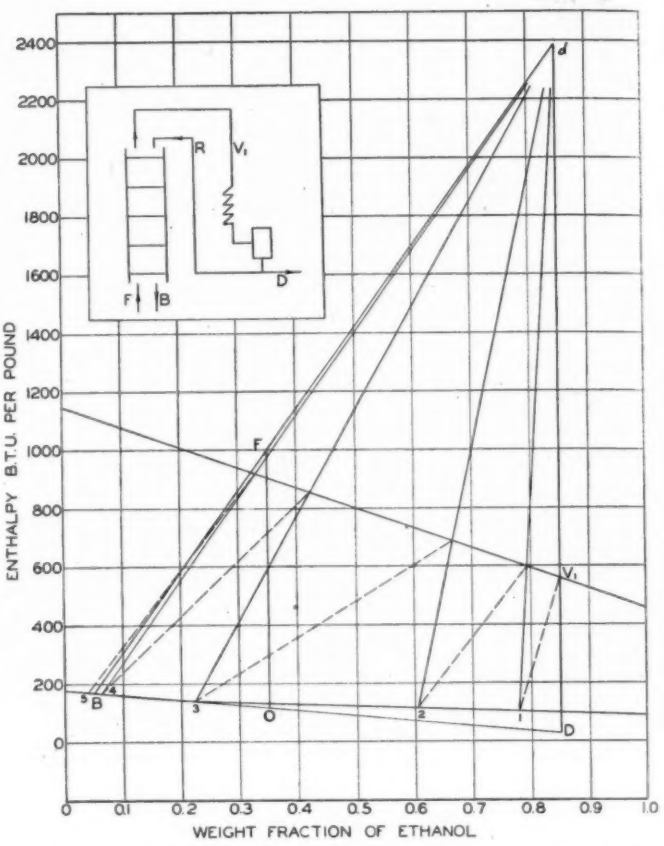


Fig. 2—Enthalpy composition diagram for a rectifying column. Simplified sketch of rectifying column is shown in inset

in a rectifying column is shown in Fig. 2, which is the solution to the following example:

Example 2.

A vapor mixture containing 35.0 %-wt. ethanol, balance water, and having an enthalpy of 1000 BTU/lb. is to be rectified in a plate column equipped with a condenser, receiver, and reflux pump. The distillate product desired contains 85.0 %-wt. ethanol and the bottom product is to contain 5.0 %-wt. ethanol. The vapor feed is to be introduced under the bottom plate. The distillate product and reflux withdrawn from the receiver will have an enthalpy of 22 BTU/lb. The column will be operated at 1 atm. pressure.

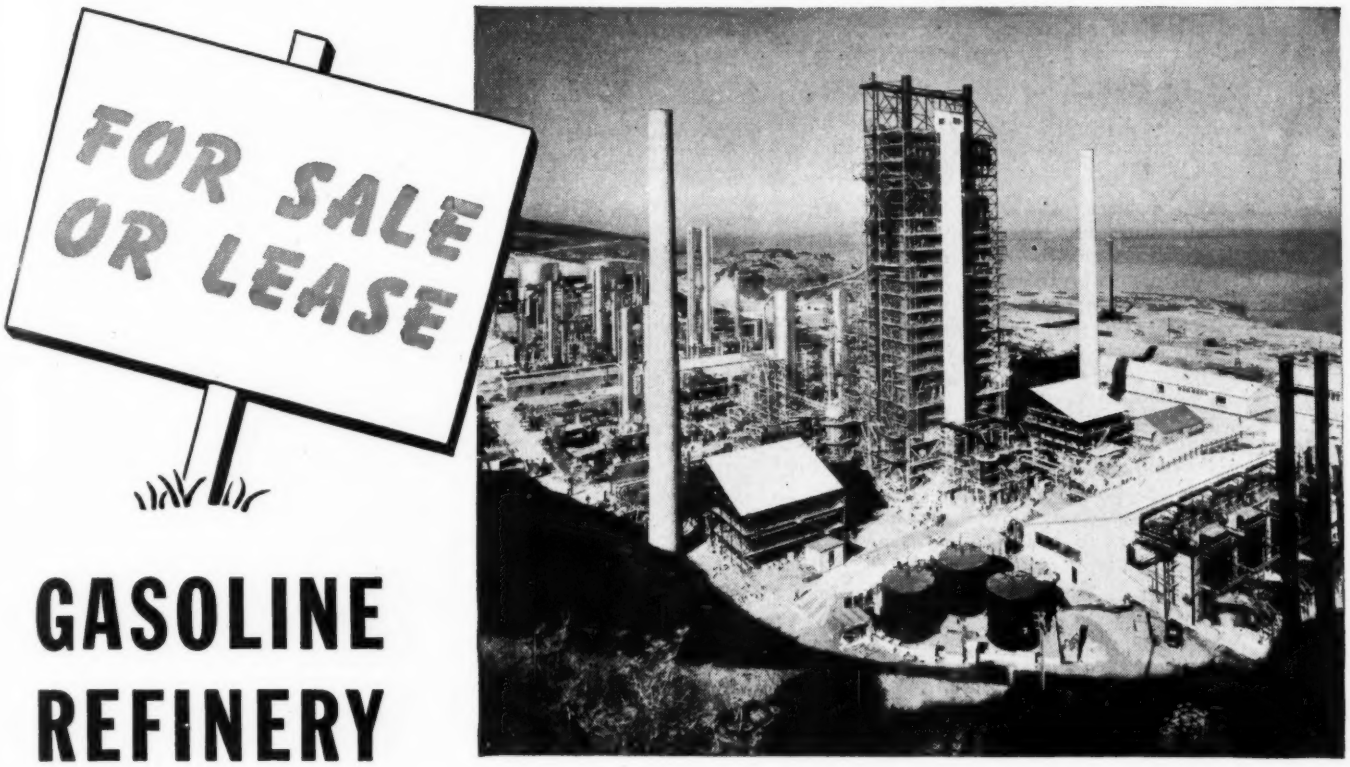
Compute:

(a) The number of equilibrium plates required.

(b) The quantity of heat transferred in the condenser per pound of feed.

The feed is represented in Fig. 2 by the point F, the bottom product by the point B, and the distillate product and reflux by the point D. The point O, representing the sum of the distillate and bottom products, lies on the straight line BD and directly below the point F, since the material entering in the feed must equal the sum of the material leaving in the products. The point O must also represent the feed plus the energy added in the condenser and therefore the distance OF represents the quantity of heat transferred in the condenser or 888 BTU/lb. of feed.

The point d, which represents the distillate product minus the energy added in the condenser per pound of distillate product, represents the difference between the vapor feed and the bottom product passing one another below the bottom plate, and also the difference between the liquid and vapor passing one an-



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other between any two plates of the column. The point d (x_D, $h_D - Q_D$) is located by extending the line BF to the value $x_D = 0.85$. The plate to plate construction is carried out as described previously. The number of equilibrium plates required is 4.4.

The calculation of the number of equilibrium plates required value chiefly for increasing the concentration of more volatile component in the distillate product. The bottom product must, of necessity, have a composition close to that of the feed since this liquid is withdrawn from the plate to which the feed is introduced.

Complete Fractionating Columns

In most commercial operations, a relatively complete separation between two components is desired. This requires a column which is capable of producing from a single feed, a distillate product containing only a very small amount of the less volatile component and a bottom product containing a very small amount of the more volatile component.

A stripping column produces a bottom product which is relatively free from the more volatile component and a rectifying column produces a product which is relatively free from the less volatile component. The features of the stripping column and the rectifying column may be combined in a single unit by placing the rectifying column on top of the stripping column. The complete fractionating column shown in Fig. 3 includes a rectifying section above the feed plate (similar to Fig. 2) and a stripping section below the feed plate (similar to Fig. 1). The feed, at any thermal condition, enters the fractionating column on an intermediate plate known as the feed plate, which constitutes the top plate of the stripping section.

The operation of the stripping section is essentially that of

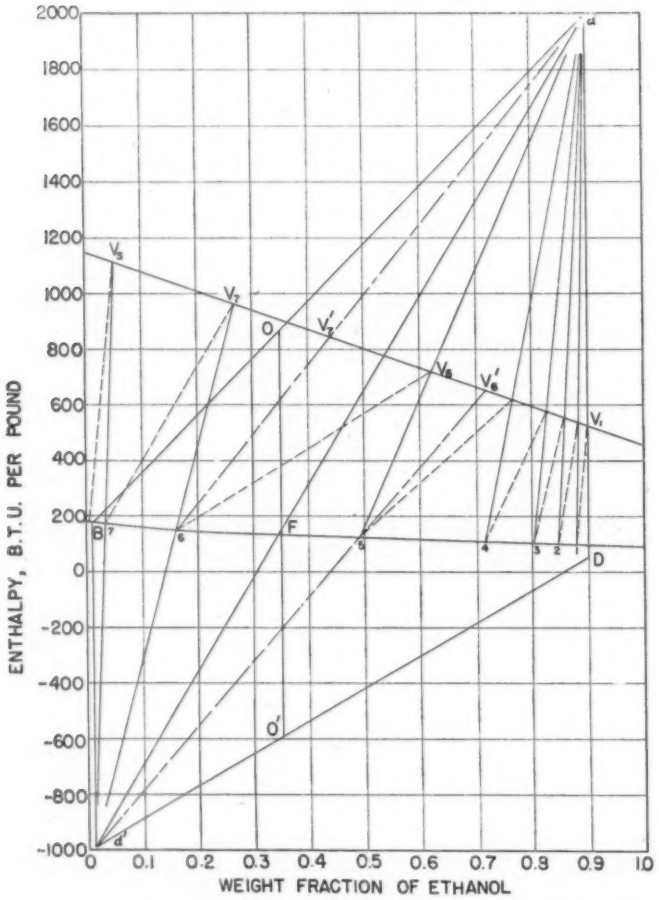

Fig. 4—Enthalpy composition diagram for the complete column shown in Fig. 3

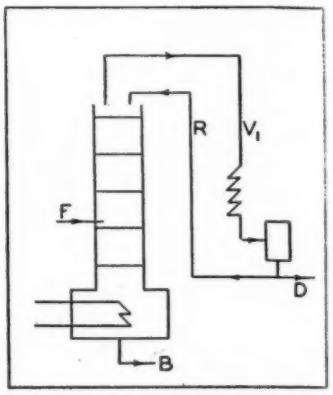

Fig. 3—Diagrammatic illustration of a complete column for a binary mixture combining stripping and rectifying operations

the stripping column shown in Fig. 1. The total liquid entering the top plate of the stripping section is composed of the feed liquid and liquid overflowing from the rectifying section above the feed plate. The purpose of the stripping section is the removal of the more volatile component from the total liquid entering the stripping section in order to produce a bottom product substantially free of the more volatile component.

The operation of the rectifying section is essentially that of the rectifying column shown in Fig. 2. The total vapor entering the bottom plate of the rectifying section is composed of the feed vapor and the vapor rising from the stripping section below the feed plate. The purpose of the rectifying section is the removal of the less volatile component from the total vapor entering the rectifying section in order to produce a distillate product substantially free of the less volatile component.

The calculation of the number of equilibrium plates required in an ordinary fractionating column is shown in Fig. 4, which is the solution to the following illustrative problem.

Example 3.

A column containing 10 plates and equipped with a still and apparatus for returning reflux is producing a distillate product containing 90 %-wt. ethanol and a bottom product containing 1.0 %-wt. ethanol, from a feed containing 35.0 %-wt. ethanol, balance water. The column operates under a pressure of 1 atm. The feed is introduced into the downspout of the seventh plate at a temperature of 183.4° F. and at the rate of 1000 lbs./hr. The distillate product and reflux are withdrawn from the reflux accumulator at 114° F. Reflux is supplied to the top plate of the column at the rate of 1170 lbs./hr. It is desired to compute the overall plate efficiency, the rate of heat transfer in the still and condenser, and the rate at which vapor is produced from the still.

In Fig. 4 the feed is a mixture of liquid and vapor having an enthalpy of 150 BTU/lb. and is represented by a point F lying on the equilibrium tie line for 183.4° F. at $x_F = 0.35$. (See Fig. 3 of the preceding article). The bottom product, withdrawn as a saturated liquid from the still is represented by the point B in Fig. 4. The distillate product and reflux are both represented by the point D, the enthalpy coordinate of 50 BTU/lb. being located by the 114° F. isotherm. The overhead vapors leaving the top plate have the same composition as the distillate product and are represented by the point V_1 on the saturated vapor line, directly above point D.

In order to calculate the number of equilibrium plates required to effect the above separation, the difference points d and d' that represent the difference between liquid and vapor passing one another in the rectifying section and in the stripping section must be located on the diagram.

Considering the rectifying section, the difference between the liquid and vapor passing one another between any two plates of the section is equal to the difference between liquid and vapor passing one another between any other two plates under steady flow conditions. This difference is equal also to

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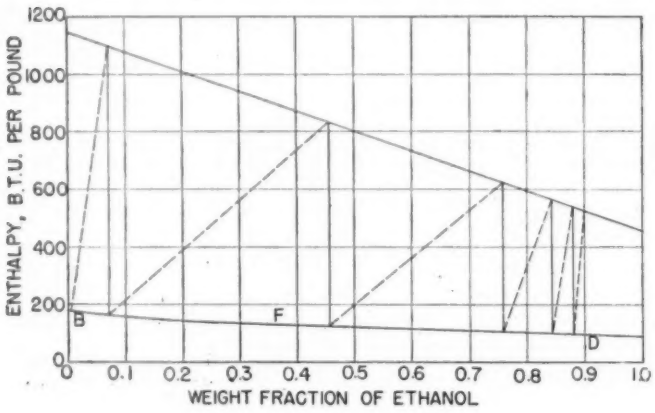


Fig. 5—Enthalpy composition diagram for a column operating at total reflux

the difference between the overhead vapors and reflux passing one another above the top plate and also to the distillate product leaving the system minus the energy added to the system in the condenser.

The combination of the distillate product and the energy added in the condenser is represented by the point d that has the coordinates (x_D, $h_D - Q_D$). The quantity of distillate product is calculated from an overall material balance as (0.35-0.01) (1000)/(0.90-0.01) = 382 lbs./hr. The quantity of reflux is 1170 lbs./hr. The quantity of overhead vapors is therefore 382 + 1170 = 1552 lbs./hr. The reflux is represented by point D, and the overhead vapors by the point V_1.

Since the quantities of these streams are known, the point d that represents the difference between the overhead vapors and reflux is located on the extension of the line DV_1, so that the ratio of the distances dV_1/dD, equals the ratio of the quantities $R/V_1 = 1170/1552 = 0.757$. The point d so located has the coordinates (0.90, 2000).

The difference between liquid and vapor passing one another between any two plates of the stripping section is equal to the bottom product withdrawn from the still less the energy added in the still and is represented by point d' having the coordinates (x_B, $h_B - Q_B$). Furthermore since the feed F, entering the column equals the sum of (1), the distillate product less the energy added in the condenser, represented by point d (x_D, $h_D - Q_D$) and (2), the bottom product minus the energy added in the still, represented by point d' (x_B, $h_B - Q_B$); the points d, F, and d' lie on a straight line. In this case the point d' is located by extending the line dF to the value $x_B = 0.01$, $h_B - Q_B = -993$.

The number of equilibrium plates are determined by a plate-to-plate construction beginning with the point V_1 representing the vapors leaving the top plate. The liquid, L_1, on plate 1 is located by the equilibrium tie line from point V_1. The point V_2 on the saturated vapor line representing the vapors rising from the second plate and passing L_1 must lie on the straight line V_2L_1d, since point d represents the difference between liquid and vapor passing one another between plates of the rectifying section.

Thus, the point V_2 is located by the intersection of the line dL_1 with the saturated vapor line. The liquid L_2 on the second plate is located by the equilibrium tie line from V_2. This procedure is followed until the feed-plate liquid is determined. Since the vapors rising to the feed plate pass the feed-plate liquid in the stripping section, the point d' is used to continue the construction until the bottom-product composition is reached.

A difficulty arises in this problem because while the actual feed-plate location is known, the equilibrium feed-plate location is not known because plate efficiency is not known. It is necessary, therefore, to assume an equilibrium feed-plate location, calculate the number of equilibrium plates in the column and then use the resulting plate efficiency to check the assumed equilibrium feed-plate location.

The final trial shown in Fig. 4 shows that 7.8 equilibrium plates are required to effect the separation when the feed is introduced on the 5.5 equilibrium plate. The still is assumed to be equivalent to one equilibrium plate, leaving 6.8 equilibrium plates in the column and giving an overall plate efficiency of 68%. The feed-plate location is on the 5.5/0.68 = 8th plate from the top of column.

The energy added in the condenser is Q_D = 2000 − 50 = 1950 BTU/lb. of distillate and the energy added in the still is Q_B = 993 + 179 = 1172 BTU/lb. of bottom product. Therefore, the rate of heat transfer in the condenser is (1950) × (382) = 745,000 BTU/hr. Similarly the still heat transfer rate is (1172) × (618) = 724,000 BTU/hr. The still heat transfer per pound of feed may be evaluated also by locating the point O on the line Bd, directly above point F. The distance OF gives the still heat transfer, BTU/lb. of feed, since the feed plus the energy added in the still, represented by point O must equal the sum of (1) the bottom product B, and (2) the distillate product less the energy added in the condenser, represented by point d. Similarly, the heat transferred in the condenser, BTU/lb. of feed is the distance FO', O' lying directly below F on the line $d'D$.

The point V_3 represents the vapor leaving the still and passing the liquid on the bottom plate, L_7. Since the point d' represents a quantity of material equal to the quantity of bott m

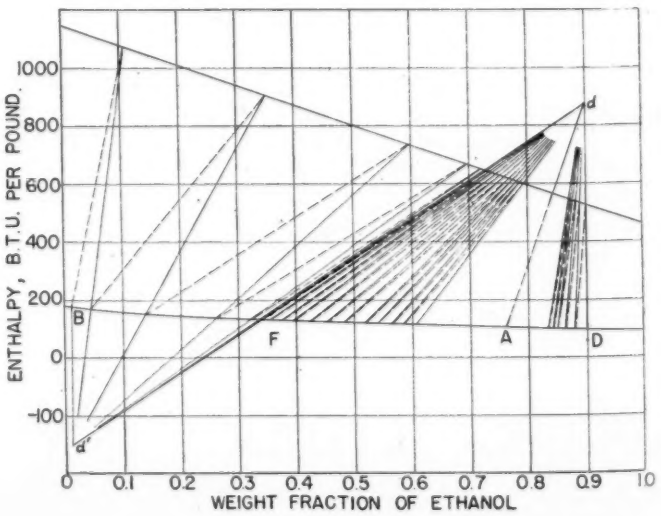


Fig. 6—Enthalpy composition diagram for a column operating at minimum reflux

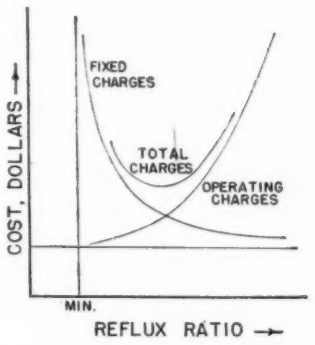


Fig. 7—Costs of fractionation as a function of reflux ratio. Low reflux ratio produces high fixed charges and low operating charges, while the condition is reversed for high ratio. Optimum reflux ratio produces minimum total charges

product, the ratio V_s/B is equal to the ratio of the distance $d'L_7/V_sL_7 = 1.24$ and thus $V_s = (1.24) \times (618) = 770$ lbs./hr.

Feed Plate Location

If the composition and thermal condition of the feed, distillate product, and bottom product are fixed and if the heat transferred in the still or in the condenser is fixed, the energy and material balances around the column and the location of the points d and d' are fixed. Under these conditions the number of plates required to effect the separation specified, is a function of the feed plate location.

In Fig. 4, the feed is introduced between equilibrium plates 5 and 6. This is an optimum location because it gives a minimum plate requirement for the separation specified. If the feed were introduced on plate 5, the composition of the vapor rising from plate 6 is determined in Fig. 4 by the intersection of the line $d'L_6$ with the vapor saturation line at V'_6. The fractionation occurring from plate 5 to plate 6 is much less and consequently the total plate requirement is greater. Similarly, if the feed were introduced on plate 7 instead of plate 6, the composition of the vapors rising from plate 7 is determined by the intersection of the line dL_6 with the vapor saturation line at V_7'. The fractionation now occurring from plate 6 to plate 7 is less. The optimum feed location is on that plate whose liquid composition is less than or equal to the composition indicated by the intersection of the overall balance line dFd' with the liquid saturation line .

There are definite limits on the location of the feed plate where a definite separation is specified and where the overall energy and material balances around the column are fixed. If the feed is introduced so far down the column that the equilibrium tie line from the feed plate liquid coincides with the line to the difference point d, the total plate requirement is infinitely large. A similar case occurs where the feed plate is so far up the column that the equilibrium tie line from the feed plate liquid coincides with the line to the difference point d'. The column will not operate under the conditions fixed, if the feed is introduced outside of these limits.

In the usual discussions of distillation problems, it is assumed that the feed is always introduced on the optimum plate.

Reflux Ratio

The term *reflux ratio* is frequently used to describe the ratio of quantity of liquid pumped back to the top plate of a fractionating column to the quantity of distillate product withdrawn.

The overhead vapors entering the condenser equals the sum of the reflux liquid and distillate product minus the energy added in the condenser. By Equation 5a* the reflux ratio is

$$\frac{R}{D} = \frac{dV_1}{V_1D} = \frac{(h_D - Q_D) - H_1}{H_1 - h_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The reflux ratio for the column whose operation is represented in Fig. 4 is $dV_1/V_1D = 3.06$.

If a distillate product of a given composition is to be produced, the effect of increasing the reflux ratio is to increase the value of $h_D - Q_D$. With a fixed thermal condition of the feed, the greater the value of $h_D - Q_D$ the lower the value of $h_B - Q_B$ for a given distillate and bottom product. The greater the distance that the difference points are removed from the saturation lines, the greater will be the fractionation accomplished by each plate, and consequently the greater the reflux ratio, the smaller the total plate requirement for a given operation.

Total Reflux

When all of the overhead vapors are condensed and returned to the column as reflux, so that no distillate product is withdrawn, the column is operating under total reflux. If no distillate product is withdrawn, no bottom product can be withdrawn and no feed can be introduced to the column. Thus the capacity of the column becomes zero although a definite separation is taking place.

Under total reflux, the reflux ratio, R/D, is infinite, and the quantity of heat removed in the condenser per unit quantity of distillate is infinite. Thus the difference points, x_D, $h_D - Q_D$ and x_B, $h_B - Q_B$ lie at an infinite distance above and below the vapor saturation line and the liquid saturation line respectively. The composition of the vapor leaving any plate is identical to the composition of the liquid overflowing from the plate above. Total reflux conditions are shown in Fig. 5, which shows that at total reflux, a minimum number of plates are required to effect a given separation.

Minimum Reflux

As the reflux ratio decreases from infinity at total reflux, the number of plates required to produce a given separation increase from a minimum value at total reflux to an infinite number at the minimum reflux ratio.

This condition will usually arise when the line dFd' coincides with the equilibrium tie line that passes through the feed point F. In this circumstance a zone of an infinite number of plates when the change in composition from plate to plate is zero develops around the feed plate. This is illustrated in Fig. 6 where the reflux ratio is somewhat above the reflux ratio which would give infinite plates at the feed plate. In this case the fractionation per plate near the feed plate has become very small.

A zone of infinite plates in some systems may develop in the rectifying section at reflux ratios higher than that which gives infinite plates at the feed plate. This occurs when one of the equilibrium tie lines in the rectifying section intersects the line dD at a higher point than the equilibrium tie line through the feed point. This is illustrated in Fig. 6, where the line Ad, the extension of the tie line through A, intersects the line dD at a higher point than any of the other tie lines in the rectifying section including that through the feed point. Here the zone of infinite plates develops at point A before it develops at the feed plate as reflux ratio is decreased.

It is conceivable that a similar situation might occur in the stripping section with some systems although this is exceedingly rare.

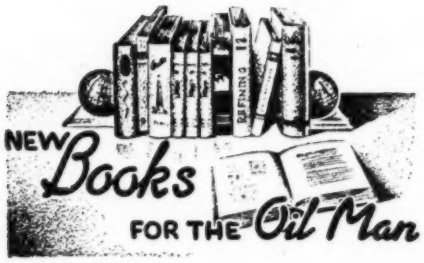
Optimum Reflux Ratio

The plate requirement for a given separation is a minimum with total reflux and zero capacity and a maximum with minimum reflux and maximum capacity. Thus all columns must be designed to operate at some reflux ratio between these limits of total and minimum reflux.

The choice of the proper reflux ratio must be based upon an economic balance. At the minimum reflux ratio, the number of plates required are infinite and therefore the investment and fixed charges are infinite. On the other hand, the operating costs are at a minimum since the duties of the condenser, still and reflux pump are at a minimum.

Conversely, at a total reflux and zero capacity, the investment and fixed charges on the column are at a minimum since the minimum number of plates are required. The operating costs are infinite, however, since the duties of the condenser, still, and reflux pump are infinite, based upon the amount of product made. Thus, the total charges of the column per unit of feed must pass through a minimum value from infinity to infinity as the reflux ratio is decreased from total reflux to the minimum reflux for any given separation. This is illustrated in Fig. 7 which shows a typical cost analysis for a given separation.

* Equation 5a in previous article.



Copies of all books reviewed on this page can be ordered from the Reader's Service Department, *Petroleum Processing*, 1213 West Third St., Cleveland 13, for the prices listed, postpaid, unless indicated otherwise. Ohio purchasers please add 3% tax.

German Grammar Is Help In Scientific Reading

German for the Scientist, by Peter F. Wiener, 5 x 7½ in., 238 pages, stiff cloth binding, $3.50.

German scientists have long been recognized for their proficiency in the technological fields (and almost proved their point in the recent war). As a result, the German scientific and technical journals and publications are frequently a source of valuable data and information.

German for the Scientist is designed for the chemist, engineer or technical man who wants to acquire a reading knowledge of scientific German, which is defined in the foreword as "the ability to extract the essential meaning of a scientific text without too much waste of time."

The book is divided into four parts. The first gives a brief summary of the grammatical and constructional difficulties and the elements of scientific German. Following that are two parts containing passages from scientific German literature (Chemistry and Physics), arranged in order of difficulty. Part four contains literal English translations of the preceding passages. Also included is a German-English vocabulary of about 2200 words.

Author of *German for the Scientist* is Peter F. Wiener, modern language master at Rugby School, England, and formerly tutor in German at the University of London.

French Dictionary Lists 6500 Technical Words and Phrases

English-French and French-English Technical Dictionary, by Francis Cusset, 5½ x 6¾ in., 590 pages, stiff cloth binding, $5.00.

Another recent addition to the aids for the translator of foreign scientific publications is the *English-French and French-English Technical Dictionary*, which contains about 6500 words and phrases. Included primarily are those terms commonly found in texts dealing with metallurgy, mining, electricity, chemistry, mechanics and science. The author, Francis Cusset, is a civil mining engineer in France.

First Revision Since 1935 For Diesel Engine Practices

Standard Practices for Stationary Diesel Engines, published by the Diesel Engine Manufacturers Association, 6 x 9 in., 157 pages, stiff cloth binding, $2.50.

Standard Practices for Stationary Diesel Engines covers design, construction, accessories, and testing of low and medium speed diesel engines, power plant buildings, specifications for fuel and lubricating oils as used in diesels and field test codes. It is the third edition of such standards published by the Diesel Engine Manufacturers Assn.; the previous edition was published in 1935, and the first edition in 1930. The new volume supersedes all previous editions of these standards.

Latest Edition of Minerals Yearbook Now Available

Minerals Yearbook, 1944, edited by C. E. Needham, U. S. Bureau of Mines, 6 x 9¼ in., 1636 pages, stiff cloth binding, $3.00, 1946.

Minerals Yearbook, 1944, is the latest complete book of information published by the Bureau of Mines covering all phases of production prices, consumption, government activities, etc. of all minerals. Included is also a summary of employment and accidents in the mineral industries and a review of foreign minerals. As in past editions, the book is profusely illustrated with tables and charts.

Helpful Trade Literature

The A-B-C of Allis-Chalmers Equipment: A 16-page booklet explaining Allis-Chalmers turbo-blowers, rotary compressors, and vacuum pumps. Designed for student training it tells what these units are, how they operate, and how to figure them. The importance of complete data for figuring blowers, etc., is pointed out by means of sketches, and diagrams. Included are pressure-volume curves, graphs on the influence of water vapor on volume, and correction curves for volumes to maintain constant air weight with changes in temperature and barometric pressure. Allis-Chalmers Mfg. Co., 677, Milwaukee 1, Wisconsin.

The Geiger-Mueller X-Ray Spectrometer: by F. G. Firth; a new 8-page booklet explaining the history and construction details of the instrument, along with circuits and data pertinent to correct usage. Practical applications, specimen preparation, and methods of identification are treated at considerable length, and well illustrated with photographs, drawings, tables, and graphs. Originally printed as an article in *Industrial Radiography*, spring issue, 1946, it is now available in pamphlet form from the author's company, North American Philips Co., Inc., 100 East 42nd Street, New York 17, N. Y.

Condenser Tubes is a 16 page brochure just off the press designed to help users of condenser tubes select the most efficient materials for their opeating equipment. Including several tables, it discusses copper, brass, and copper base alloys and their chemical and physical characteristics as applied to condenser and heat exchanger use. A comprehensive graph gives safe working pressures. Two pages are devoted to estimating data covering tube sizes from ⅝ in. to 2 in. O.D. Wolverine Tube Division of Calumet and Hecla Consolidated Copper Co., 1411 Central Ave., Detroit 9, Mich.

Petroleum Refining: A sixty page booklet, spiral bound, describing in detail some 27 typical examples of the more than 300 processing units designed and constructed by the Foster Wheeler Corp. for the petroleum industry. A table of the properties of hydrocarbons helpful for refiners is provided. Foster Wheeler Corp., 165 Broadway, New York, N. Y.

Direct Current Remote Indication and Control Systems: A 12-page engineering booklet explaining remote indicating and control systems—what they are, how they work, and their applications. The bulletin, Mo. 14B6641, is available on request to Allis-Chalmers Mfg. Co., 686, Milwaukee 1, Wis.

Aerocat Grade MS-A Synthetic Fluid Cracking Catalyst: An 8-page booklet giving various physical properties, activity, and severity factor of the new microspheroidal catalyst used in fluid cracking processes, by American Cyanamid Co., Petroleum Chemicals Department, 30 Rockefeller Plaza, New York 20, N. Y.

Alco Evaporators is a new booklet describing the evaporator "flex-tube" design of the American Locomotive Co. The design is described by Alco as "the only positive acting true thermo-mechanical descaling device for straight tube installation." American Locomotive Co., 30 Church St., New York 8, N. Y.

Alkylation and Polymerization. . . Their Effect on Refinery Earnings, a 7-page article in *The Kelloggram*, 1946 series, Issue No. 4, presents an economic comparison of the two processes. The effect on refinery earnings of operating costs and availability of raw materials is discussed. Dollar returns for each process at five actual commercial operations in refinery locations representative of different areas are presented. The M. W. Kellogg Co., 225 Broadway, New York 7.

PERSONALS

Petroleum Technologists in the Headlines

Dr. **Frederick D. Rossini** has been elected President of the International Committee on Thermochemistry of the International Union of Chemistry. He is chief of the Thermochemistry and Hydrocarbons Section of the National Bureau of Standards.

Dr. Rossini

Dr. Rossini is Supervisor of the API Research Projects on the "Analysis, Purification and Properties of Hydrocarbons" and the "Collection, Analysis and Calculation of Data on the Properties of Hydrocarbons."

Dr. Rossini received a bachelor's degree in Chemical Engineering in 1925 and a master's in science in 1926 from Carnegie Institute of Technology, and a doctorate in Physical Chemistry in 1928 from the University of California. Before joining the staff of the Bureau of Standards in 1928, the Doctor taught at his alma mater, Howard University, and at Catholic University of America.

* * *

Rear Adm. Luis de Florez, known in the oil industry as a refinery equipment designer and builder, has returned to the presidency of the De Florez Engineering Co., in New York. His plans are to undertake a long-term research program on automatic machinery. While in the Navy he was deputy chief of the Office of Naval Research.

* * *

Formerly with the J. S. Abercrombie Co., Old Ocean Refinery, **H. A. Grebe** and **E. P. Doremus,** have established a consulting service in Houston as process specialists.

Mr. Grebe was superintendent of operations while Mr. Doremus was chief chemist and process engineer with Abercrombie.

The two men plan to cater to the small refiner and have selected for their firm designation "Refinery and Light Hydrocarbon Process Consultants."

* * *

Dr. D. F. Edwards, formerly assistant head of the Technical Service Division of Baton Rouge for Standard of New Jersey, has been appointed assistant process superintendent.

* * *

Dr. Warren F. Faragher of the Houdry Process Corp., has gone to Europe for the U. S. Government as a representative to supervise the preparation by the Germans of the final reports on the German petroleum processes.

He will complete the collection of the German information on the programs surveyed by the U.S. Technical Oil Mission which was sent to Germany by PAW in 1945.

At the time the chaos resulting from the war and the displacement of German technical personnel left unanswered many of the questions concerning German use of hydrogenation, catalytic cracking, etc. In the past year, however, many of the missing technicians and numerous documents have been located; from them Dr. Faragher expects to obtain the necessary data for the completion of the reports.

Dr. Faragher has been associated with Houdry Process Corp., since its formation in 1931 and was a former Assistant Director of Mellon Institute of Industrial Research.

* * *

Vice-chairman of the Petroleum Division of the American Chemical Society for 1946-47 is **Dr. A. N. Sachanen,** Socony-Vacuum Oil Co.

Born in Viipuri (Viborg), Finland, Dr. Sachanen was graduated from the Imperial University in Moscow and later received the Doctor of Science degree from the Imperial University in Odessa, where for several years he was professor of chemistry.

Dr. Sachanen

He left that post after the revolution and joined the petroleum industry as director and general manager of the Research Petroleum Institute in Grozny, which under his direction grew to a membership of 450 to 500 in 1928-29.

In 1929, he visited the U. S. as advisor on the purchase of cracking and distillation equipment for the Russian government-controlled oil trusts.

He left Russia in 1931 for Finland and later for Western Europe, working chiefly in Paris as a consultant for French refineries. In 1935 he came to the U. S. and joined the research department at Socony-Vacuum.

He is the author of numerous articles, patents, and books, two of which have been published in this country during the last six years: "Conversion of Petroleum," and "Chemical Constituents of Petroleum."

* * *

Robert L. Whiting has joined the staff of the petroleum engineering department at Texas A. & M. College as associate professor. He formerly held the same position with the Missouri School of Mines, Rolla, Missouri.

Mr. Whiting served as an instructor of Petroleum Engineering at the University of Texas prior to the 1945-1946 school term at Missouri. He has been with Sinclair Oil and Refining Co., at Houston as a foreman, the railroad Commission of Texas as a natural gas engineer, and with the Stanolind Oil and Gas Co.

* * *

Chief engineer **E. W. McAllister** of the Western Gulf Oil Co. has been transferred to London to assume the post of chief petroleum engineer for Kuwait Oil Co., Ltd.

* * *

Dr. Alex G. Oblad has joined the staff of the Texas State Research Foundation as acting head chemist. He was formerly with the Magnolia Petroleum Co., as chief chemist of the field research laboratories.

* * *

J. R. Vannoy has been named general foreman of the cracking and perbunan department of the Baton Rouge plant of Standard Oil Co., of New Jersey.

* * *

Robert C. Kuder has joined the staff of the chemistry department at the University of Dayton as an assistant Professor. He formerly was with the Standard Oil Co., of Indiana as research chemist at their Whiting Refinery.

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WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers is Invited

Companies Can Offer Technical Personnel More Than the Unions

Technical personnel in refineries more and more will be confronted with efforts by the outside labor unions to organize the plant professional workers. This raises for the oil companies a different set of problems in the labor organization movement than they have heretofore encountered.

Government labor boards are advocating the formation of bargaining units among the young engineers and chemists, along with the other workers not in supervisory or management jobs. Union organizers are making much of a talk by Chairman Davis, of the National Labor Relations Board before the American Society of Civil Engineers some months ago, in which he said the Wagner act applied to the professional men as much as to other kinds of workers.

The civil engineers society has met this situation by amending its constitution and by-laws to provide for local committees which can act upon request for a group of its members and thus set up a bargaining unit which will be recognized by the Wagner Act. By this means, at least the civil engineers will be represented in bargaining efforts by men of their own kind, who have primarily the interests of the professional men at heart, and not those of the outside unions and their organizers. However, this is a situation the oil companies will have to meet regardless of what the technical societies do.

In the main, the young professional engineer and chemist is outspoken in a natural dislike of the labor unions and their ways. The fact he has acquired a degree in his profession in itself means he has more than the average ambition to make himself useful to society through his work. Even before he has finished his college training he has come to realize that advancement in his profession depends on freedom of initiative for him and independence in his thinking. He recognizes the stultifying effect upon the individual of the "seniority" and "security" clauses in the union contracts of today.

The young technologist, fresh out of school, also realizes that, while he has invested in from $3000 to $6000 or more in his specialized training, he must serve an "internship" in industry, at a lower rate of pay than the first class craft workers receive, before he can begin to secure the return from his investment in his education. He wants to be assured, however, that he will later be rewarded by his company in proportion to the value of his scientific contributions.

Unfortunately, too often the professional man starting in at the refinery, as in other industrial concerns, finds himself buried in purely routine work in the engineering drafting room or the laboratory. He may even be under a supervisor who will hold back the young technologist because he is afraid the expression of fresh ideas will reflect on his own lack of ability. The ambitious engineer or chemist starting out under such circumstances misses the inspiring contacts of his preparatory days and often he doesn't know how to keep them up entirely through his own efforts.

Oil company executive staffs can find several ways to provide the means to help young professional workers keep alive their interest in the profession during their first working years. Groups for study and discussion in scientific fields can be sponsored by the company, the same as recreational activities are now sponsored. These would be particularly valuable to the technologists where the refineries are located in small communities and the number of professional men there all told is too small to support chapters of the national scientific societies.

Outside speakers, authorities in the various fields of refining technology, could be brought in by the company a few times a year to talk to the technical personnel. Along this line Humble Oil & Refining Co. has inaugurated at its Baytown refinery two annual series of lectures for its technical and research men. Personnel selected by the company to receive these courses devotes full time to them for the periods, up to two weeks, in which they are presented.

The policy of financial recognition for progress in straight research work has been emphasized by Standard Oil Development Co. In a letter to all professional employes it was pointed out that men concentrating on scientific work, on the basis of their contributions, can receive salaries in line with those paid men carrying major administrative responsibilities.

Programs by the oil companies to keep alive the interest of their young professional men in their chosen fields of science during their early working years, and assurance their rewards will be in proportion to their scientific contributions, will have broader benefits to the men than the outside unions can offer. Stimulating the thinking and aiding the ambitions of men to progress in any branch of science will also lead to future technological developments of value to the entire industry.

Long Range Profits from Research

While the outcome of any individual project is largely a gamble, in research and development carried on over a period of time the successes should more than pay for the failures, E. V. Murphree, executive vice president of Standard Oil Development Co., told the American Gas Association recently. He cited figures on research dealing primarily with manufacturing carried on by his company, on behalf of Standard Oil Co. (New Jersey). The figures cover a period of 10 years and were given in terms of savings or profit per $1000 spent on research and development.

> Savings in royalty payments that would otherwise have been required; $3722: Savings due to improvements in existing processes and products, $9620: Added profits due to the development of new products, $2070: Total, $15,412.

In the two latter categories, Mr. Murphree pointed out, the manufacturing and marketing groups also made substantial contributions and the savings and profits were not solely due to research and development. However, in all cases, he said, the initiation of the effort would probably not have come about except through research and development.

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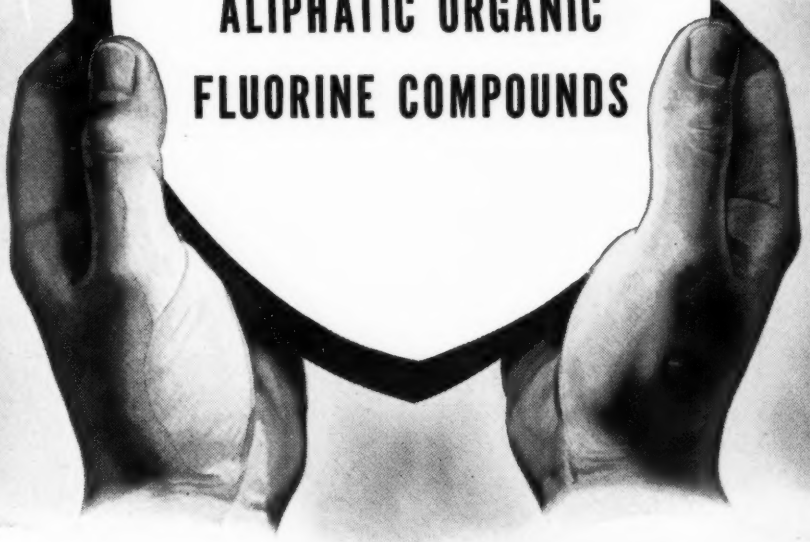

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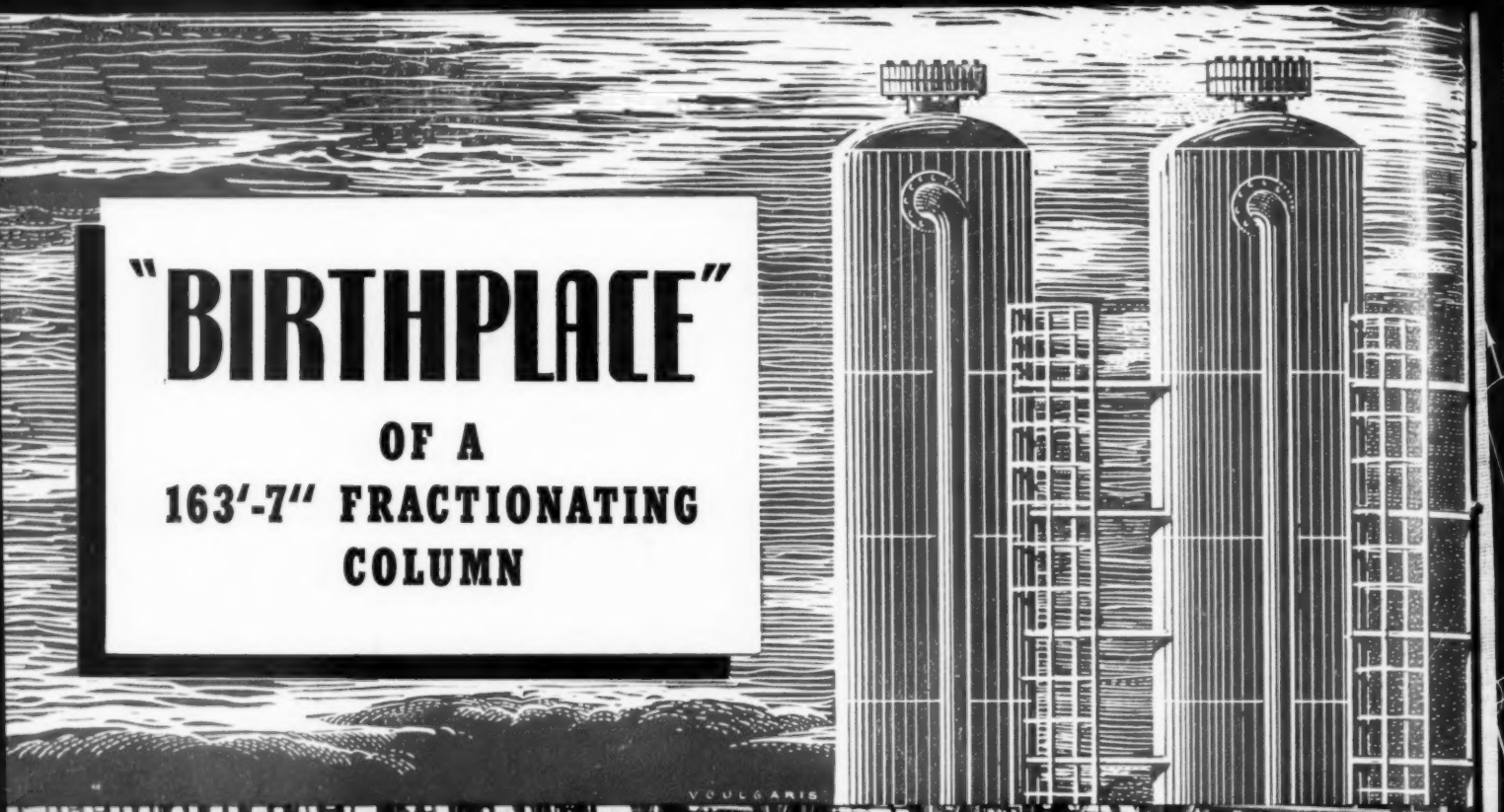

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